Japanese longline CPUE for yellowfin tuna in the Indian Ocean up to 2009 standardized by general linear model

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Abstract

Japanese longline CPUE for yellowfin tuna was standardized up to 2009 by GLM (CPUE-LogNormal error structured model). Number of hooks between float (NHF) and material of main line and branch line were applied in the model to standardize the change of the catchability which has been derived by fishing gear configuration. SST (Sea Surface Temperature) which was included in the model in the previous analysis as oceanographic factor was not applied this time because high catch rate at the low temperature in Area3 cause unnatural trend of CPUE. Quarterly and annual CPUEs in the main fishing ground and whole Indian Ocean were standardized to provide abundance index for yellowfin assessment using standard models, such as ASPM, in the IOTC WPTT in 2010. Additionally, quarterly CPUE in each area in each of five areas in the whole Indian Ocean was also standardized for the assessment using Multifan-CL and SS3.

Trends of annual CPUEs for main fishing ground in the Indian Ocean (Area 2, 3 and 5) and whole Indian Ocean standardized from 1960 through 2009 using L5, L1 and set by set data were shown in Fig. 2 in real scale overlaying nominal CPUE and in relative scale. Basically, CPUE trends derived from different data sets were similar. In the main fishing ground, CPUE continuously decreased from around 15 (real scale) in early 1960s to around 5.0 in 1974, and was kept in same level until 1992 with jump to 10.0 in 1977. Thereafter, it declined to about 3.0 in 1994 and has been kept in the low level with fluctuation between 2.3 and 3.2 until 2006. After that, the CPUE declined to about 1.2 in 2008 and 2009 although the data of 2009 is still preliminary. The trend of standardized CPUE for whole Indian Ocean was similar to that of main fishing ground, and also shows remarkable decrease in the last three years.

1. Introduction

Japanese longline CPUE for yellowfin tuna was standardized by Generalized Linear Model up to 2009. Methods of standardization was basically equivalent to those used for the last yellowfin assessment (Okamoto et al., 2009) except of that SST (Sea Surface Temperature) which was applied in the model in 2008 analysis (Okamoto and Shono 2008) was not applied in the model in this analysis. Number of hooks between float (NHF) and material of main line and branch line were applied in the model to standardize the change of the catchability which has been derived by fishing gear configuration. Area definition used was the same as that used in 2009 analysis.

2. Materials and methods

Principally, the model used for the standardization in this paper is similar to that used in the yellowfin assessment last year (Okamoto et al., 2009). However SST (Sea Surface Temperature) which was included in the all GLM model last year was not applied to initial model and was applied only to the run of comparison.

Area definition:

Area definition used in this study which consists of five areas was as same as that used in the yellowfin assessment in IOTC WPTT 2009 (Fig. 1).

Environmental factors:

As an environmental factor, SST (Sea Surface Temperature) which is available for the analyzed period from 1960 to 2009 was applied only to run for thepurpose of comparison. The original SST data, whose resolution is 1-degree latitude and 1-degree longitude by month from 1946 to 2004, was downloaded from NEAR-GOOS Regional Real Time Data Base of Japan Meteorological Agency (JMA). http://goos.kishou.go.jp/rrtdb/database.html It is necessary to get password to access the data retrieving system. For the analyses using catch and effort data aggregated by 5-degree latitude and 5-latitude longitude by month, the SST data was re compile into the same strata from 1960 to 2009 using the procedures described in Okamoto et al. (2001), and used in the analyses.

Catch and effort data used:

The Japanese longline catch (in number) and effort statistics from 1960 up to 2009 were used. 2009 data is preliminary. Data of three types of resolution, i.e. L5, L1 and set by set data were applied. L5 (L1) were the catch and effort data sets aggregated by month, 5-degree (1-degree) square, NHF (the number of hooks between floats), and main and branch line material. Set by set data is data of each longline operation, and is not aggregated data. As for the aggregated data set, data in strata in which the number of hooks was less than 5000 were not used for analyses. As the NHF information does not available for the period from 1960 to 1974, NHF was regarded to be 5 in this period. Main and branch line material was classified into two categories, 1 = Nylon and 2 = other. Although this information on the materials has been collected since 1994, the nylon material was started to be used by distant water longliner in the tropical Indian Ocean in around the late 1980s and spread quickly in the early 1990s (Okamoto 2005). And it seems that the larger number of NHF than 17 or 18 would become possible to be used as a result of introduction of the new material. Therefore, the material of NHF 17 or larger was assumed to be nylon since 1990.

GLM (Generalized Linear Model)

CPUE based on the catch in number was used. CPUE is calculated as “the number of caught fish / the number of hooks * 1000” As the model for standardizing CPUE, CPUE-LogNormal error structured model was used. The followings are the initial model for each analysis. Basing on the result of ANOVA (type III SS), non-significant effects were removed in step-wise from the initial model based on the F-value ($p<0.05$).

Annual and quarterly CPUE was standardized for main fishing ground (Area 2, 3 and 5) and whole Indian Ocean (Area 2-5) for three time series, 1960 (1963) – 2009, 1968-2009 and 1980-2009. In addition, quarterly CPUE was also standardized for each of five areas for 1963-2009 in order to provide CPUE index used for assessment using Multifan-CL software and Stock Synthesis 3 (SS3).

- Initial Model for Year based CPUE standardization in the main fishing ground and whole Indian Ocean for 1960 (1963 for L1 and set by set analyses) through 2009

Log (CPUE+const)= μ +YR +QT +AREA +NHFCL +ML +BL ~~+SST +SST2 +SST3~~ +YR*QT +QT*AREA +YR*AREA +AREA*NHFCL +NHFCL*ML +NHFCL*BL ~~+AREA*SST +YR*SST~~

- Initial Model for Quarter based CPUE standardization in the main fishing ground and whole Indian Ocean for 1960 (1963 for L1 and set by set analyses) through 2009

Log (CPUE+const)= μ +YR +QT +AREA +NHFCL +ML +BL ~~+SST +SST2 +SST3~~ +YR*QT*AREA +AREA*NHFCL +NHFCL*ML +NHFCL*BL ~~+AREA*SST +YR*SST~~

- Initial Model for quarter based CPUE standardization in each area for whole Indian Ocean from 1963 through 2009 (analyzed only for L1 data set)

Log (CPUE+const)= μ +YR +QT + NHFCL +ML +BL +SST +SST2 +SST3 +YR*QT +NHFCL*ML +NHFCL*BL +YR*SST

Where Log : natural logarithm,
CPUE : catch in number of bigeye per 1000 hooks,
Const : 10% of overall mean of CPUE
μ : overall mean,
YR : effect of year,
QT : effect of fishing season (quarter)
Area: effect of area,
NHFCL : effect of gear type (category of the number of hooks between floats),
SST : effect of SST (as a continuous variable),
SST2 : effect of SST2 (=SST x SST, as a continuous variable),
SST3 : effect of SST3 (=SST x SST x SST, as a continuous variable),
MLD: effect of MLD (mixing layer depth),
ML : effect of material of main line,
BL : effect of material of branch line,
YR*QT : interaction term between year and quarter,
QT*Area: interaction term between quarter and area,
YR*Area: interaction term between year and area,
Area*NHFCL: interaction term between area and gear type,
NHFCL*ML: interaction term between material of gear type and main line,
NHFCL*BL: interaction term between material of gear type and branch line,
Area*SST : interaction term between area and SST,
YR*SST : interaction term between year and SST,
YR*QT*Area : interaction term between year, quarter and Area,
e : error term.

The number of hooks between float (NHF) was divided into 6 classes (NHFCL 1: 5-7, NHFCL 2: 8-10, NHFCL 3: 11-13, NHFCL 4: 14-16, NHFCL 5: 17-19, NHFCL 6: 20-21) as later explanation.

Effect of year was obtained by the method used in Ogura and Shono (1999) that uses lsmean of Year-Area interaction as the following equation.

CPUEi = Σ Wj * (exp(lsmean(Year i*Area j))-constant)
Where CPUEi = CPUE in year i,
Wj = Area rate of Area j , (Σ Wj = 1),
lsmean(Year*Areaij) = least square mean of Year-Area interaction in Year i and Area j (As for the quarter based CPUE, least square mean of Year*Quarter*Area was used instead),
constant = 10% of overall mean of CPUE.

Effect of explanatory factors on the CPUE trends:

In order to know the effect of each explanatory factor on the standardized CPUE trend, effects of adding factors into the model in stepwise manner was observed using L1 data set for main Indian Ocean from 1963 to 2009.

3. Results and discussion

CPUE standardizations by GLM:

The yellowfin CPUEs (catch in number per 1000 hooks) in year and quarter bases were standardized for the period from 1960 (1963) to 2009 by GLM (CPUE-LogNormal error structured model) for each of area categories, main fishing ground (Area 2, 3 and 5) and whole Indian Ocean (Areas 2 – 5). Results of ANOVA and distributions of the standard residual for both of annual and quarterly CPUE for main and whole Indian Ocean were shown in Table 1 and Figs. 2 and 3, respectively. As all explanatory factors included in the initial models were effective significantly in all cases, final models were equal to the initial models as a result. In all cases, standard residual did not show remarkable difference from the normal distribution (Figs. 4 and 5).

Trends of annual CPUEs for main fishing ground in the Indian Ocean (Area 2, 3 and 5) and whole Indian Ocean standardized from 1960 through 2009 using L5, L1 and set by set data were shown in Fig. 2 in real scale overlaying nominal CPUE and in relative scale. Basically, CPUE trends derived from different data sets were similar. In the main fishing ground, CPUE continuously decreased from around 15 (real scale) in early 1960s to around 5.0 in 1974, and was kept in same level until 1992 with jump to 10.0 in 1977. Thereafter, it declined to about 3.0 in 1994 and has been kept in the low level with fluctuation between 2.3 and 3.2 until 2006. After that, the CPUE declined to about 1.2 in 2008 and 2009 although the data of 2009 is still preliminary. The trend of standardized CPUE for whole Indian Ocean was similar to that of main fishing ground, and also shows remarkable decrease in the last three years. Quarterly CPUE trends for main and whole Indian Ocean were basically similar to that of annual CPUE (Fig. 3).

In order to provide CPUE index used in Multifan-CL and SS3 analyses, quarterly CPUE of each five areas were separately standardized for the period from 1963 to 2009 as described in the materials and method section. Standardized CPUE in each area were shown in Fig. 6 in real scale overlaying nominal CPUE and in relative scale. ANOVA tables and standard residuals were shown in Table 2 and Fig. 7, respectively. Trends of CPUEs of areas were relatively similar, i.e. large decline to middle 1970s, relatively stable trend until around 1991 and steadily declining trend thereafter.

Annual and quarterly CPUE standardized for main and whole Indian Ocean and quarterly CPUE standardized for each of five areas were listed in Appendix Table 1, 2 and 3, respectively, in real and relative scales with variation. As for the CPUE for main and whole Indian Ocean, not only time series from 1960 (1963) to 2009 but also other two time series, 1968-2009 and 1980-2009 were calculated for other possible assessment methods.

Effect of SST on the CPUE trend:

In the GLM model applied for CPUE standardization used for yellowfin stock assessment in 2008, SST (Sea surface temperature) was included as a oceanographic factor. In the analysis this year, unnaturally high CPUE was observed in the period from 1977 to 1979 when SST was included in the model. Although SST was also applied in the analyses in 2008, this protruding CPUE was not recognized. In the stock assessment of last year, Area definition of Area3 was modified to include from 30ºS to 40ºS and this expanded south area is thought to be the reason of this phenomenon. Comparing CPUEs standardized with SST in the model using new and old Area3 definitions, this high CPUE from 1977 to 1979 was not detected in the CPUE using old Area3 definition (Fig. 8). In Fig. 9, historical change in average CPUE by SST and by year was plotted for each area in which new (left) and old (right) definitions were applied for Area3. In all areas, most of high CPUE exist at the SST higher than 24ºC. However in Area3 of new definition which includes south of 30 ºS, bunch of very high CPUE was appeared sporadically at the lower temperature from 15ºC to 23ºC. In the period from 1977 to 1979 when the jump of CPUE was observed such a high CPUEs at lower temperature were remarkable. As the positive relationship between SST and CPUE is detected in the GLM, unpredictable high CPUE in lower temperature would be interpreted as extraordinary high CPUE by standardization procedure. South part of Area 3, especially off Cape Town is known as frontal zone between warm and cool currents, and it is supposed that the temperature of each catching site estimated by matching with oceanographic data may not be reliable at such a frontal area. Therefore, it was decided not to apply the SST information in the model as far as new area definition in Area3 is used in the CPUE standardization.

Effect of each explanatory factors in the model

Trends of CPUE standardized for each of quarter, NHFCL, gear (main-line and branch-line) materials and interaction of NHFCL and gear materials were shown in Figs.10. L1 data set and main Indian Ocean were used for this analysis. CPUE was highest in 1st and 4th Quarter. Regarding NHFCL, CPUE was almost same level around 3.0 for NHFCL 1 through 5, while that of NHFCL 6 is largest about 4.5. As for the gear materials of both of branch and main-lines, Nylon showed about 10% higher CPUE than other material. Since the combinations of NHFCL with gear materials did show clear difference in CPUE between nylon non-nylon for both of main and branch line, largest NHFCL shows highest CPUE for both material categories.

By adding explanatory factors into the model in stepwise manner, effect of each factor was observed (Fig. 11). In this analysis, adding one factor means to add it as main factor and related interactions into the model. In the comparison of relative CPUE in which average of annual CPUE from 1963 to 2009 was set to 1.0, nominal and standardized CPUE showed relatively similar trends until 1993 except relatively lower nominal CPUE from 1983 to 1989. In the case of models which include Year, Year+Quarter or Year+Quarter+Area, standardized CPUE became lower than nominal CPUE. This separation of both CPUEs seems to be derived from high concentration of effort with high CPUE in to small regions of western tropical Indian Ocean. By adding NHFCL and gear materials (final model), standardized CPUE became lowered since 1994. In early 1990s, Nylon material was started to be used as material of main and branch lines, and introducing this new material seems to have enabled to utilize NHF larger than 17. As the CPUE of largest NHFCL (NHF=20 or 21) is about 50% higher than other smaller number of NHF, standardized CPUE after introduction of new material would be lowered adjusting by the gear effects.

4. Recerences

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Okamoto, H., Miyabe, N., and Matsumoto, T. (2001): GLM analyses for standardization of Japanese longline CPUE for bigeye tuna in the Indian Ocean applying environmental factors. IOTC/TTWP/01/21, 38p.

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Okamoto, H. and Shono, H. (2008): Standardization of annual and quarterly CPUE for yellowfin tuna caught by Japanese longline fishery in the Indian Ocean up to 2007 using general linear model. IOTC/WPTT/08/19. 22 pp.

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Table 1. ANOVA table of GLM for year (left) and quarter (right) based CPUE standardized using L1 data set for main (top) and whole (bottom) Indian Ocean from 1960 to 2009

1963-2009 Year base (1 degree X 1 degree X month)
Main Fishing Ground (Area 2&3&5)

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	314	65349.078	208.118	249.630	<.0001	R-Square= 0.308393
						CV = 59.34249
yr	46	11188.0862	243.21926	291.73	<.0001	
qt	3	3498.61006	1166.20335	1398.81	<.0001	
area	2	1900.41062	950.20531	1139.73	<.0001	
nhfcl	5	520.98749	104.1975	124.98	<.0001	
bl	1	20.86134	20.86134	25.02	<.0001	
ml	1	145.70313	145.70313	174.77	<.0001	
yr*qt	138	4711.34751	34.1402	40.95	<.0001	
qt*area	6	5277.92971	879.65495	1055.11	<.0001	
yr*area	92	5070.11619	55.10996	66.1	<.0001	
area*nhfcl	10	751.52626	75.15263	90.14	<.0001	
nhfcl*ml	5	276.61612	55.32322	66.36	<.0001	
nhfcl*bl	5	57.91875	11.58375	13.89	<.0001	

1963-2009 Quarter base (1 degree X 1 degree X month)
Main Fishing Ground (Area 2&3&5)

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	590	71072.611	120.462	150.130	<.0001	R-Square= 0.335404
						CV = 58.21788
yr	46	9432.72431	205.05922	255.55	<.0001	
qt	3	2801.84393	933.94798	1163.93	<.0001	
area	2	1299.07379	649.53689	809.48	<.0001	
nhfcl	5	473.48951	94.6979	118.02	<.0001	
bl	1	17.16358	17.16358	21.39	<.0001	
ml	1	141.47866	141.47866	176.32	<.0001	
yr*qt*area	512	21915.4686	42.80365	53.34	<.0001	
area*nhfcl	10	736.79905	73.67991	91.82	<.0001	
nhfcl*ml	5	243.44185	48.68837	60.68	<.0001	
nhfcl*bl	5	45.95486	9.19097	11.45	<.0001	

1963-2009 Year base (1 degree X 1 degree X month)
Whole Indian (Area 2-5)

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	369	158734.561	430.175	499.870	<.0001	R-Square= 0.446619
						CV = 80.23678
yr	46	13470.7873	292.8432	340.29	<.0001	
qt	3	4324.92788	1441.64263	1675.2	<.0001	
area	3	7958.6298	2652.8766	3082.66	<.0001	
nhfcl	5	500.4712	100.09424	116.31	<.0001	
bl	1	50.06941	50.06941	58.18	<.0001	
ml	1	85.24001	85.24001	99.05	<.0001	
yr*qt	138	5254.72501	38.07772	44.25	<.0001	
qt*area	9	6783.78802	753.75422	875.87	<.0001	
yr*area	138	7764.61882	56.26535	65.38	<.0001	
area*nhfcl	15	943.08071	62.87205	73.06	<.0001	
nhfcl*ml	5	384.60295	76.92059	89.38	<.0001	
nhfcl*bl	5	88.59864	17.71973	20.59	<.0001	

1963-2009 Quarter base (1 degree X 1 degree X month)
Whole Indian (Area 2-5)

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	783	168718.775	215.477	263.300	<.0001	R-Square= 0.47471
						CV = 78.24459
yr	46	10737.984	233.434	285.240	<.0001	
qt	3	3616.105	1205.368	1472.880	<.0001	
area	3	6942.877	2314.292	2827.910	<.0001	
nhfcl	5	417.260	83.452	101.970	<.0001	
bl	1	41.125	41.125	50.250	<.0001	
ml	1	92.970	92.970	113.600	<.0001	
yr*qt*area	699	31156.654	44.573	54.470	<.0001	
area*nhfcl	15	948.201	63.213	77.240	<.0001	
nhfcl*ml	5	326.334	65.267	79.750	<.0001	
nhfcl*bl	5	75.141	15.028	18.360	<.0001	

Table 2. ANOVA table of GLM for quarter based CPUE for each of five areas 2-5 in whole Indian Ocean from 1963 to 2009

1963–2009 Quarter base (1 degree X 1 degree X month)

Area 2

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	204	23232.816	113.886	155.930	<.0001	R–Square= 0.299
						CV =
yr	46	7401.172	160.895	220.300	<.0001	47.537
qt	3	487.157	162.386	222.340	<.0001	
nhfcl	5	145.455	29.091	39.830	<.0001	
bl	1	10.665	10.665	14.600	0.000	
ml						
yr*qt	138	3896.828	28.238	38.660	<.0001	
nhfcl*ml	6	149.688	24.948	34.160	<.0001	
nhfcl*bl	5	47.978	9.596	13.140	<.0001	

Area 4

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	204	27891.982	136.725	87.400	<.0001	R–Square= 0.253
						CV =
yr	46	8275.173	179.895	114.990	<.0001	−128.771
qt	3	2029.588	676.529	432.440	<.0001	
nhfcl	5	796.230	159.246	101.790	<.0001	
bl	1	25.639	25.639	16.390	<.0001	
ml	1	48.252	48.252	30.840	<.0001	
yr*qt	138	9516.221	68.958	44.080	<.0001	
nhfcl*ml	5	70.384	14.077	9.000	<.0001	
nhfcl*bl	5	200.307	40.061	25.610	<.0001	

Area 3

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	204	22499.737	110.293	104.390	<.0001	R–Square= 0.289
						CV =
yr	46	4966.593	107.969	102.190	<.0001	71.960
qt	3	6663.873	2221.291	2102.330	<.0001	
nhfcl	5	351.588	70.318	66.550	<.0001	
bl						
ml	1	10.858	10.858	10.280	0.001	
yr*qt	138	4905.431	35.547	33.640	<.0001	
nhfcl*ml	5	266.657	53.331	50.480	<.0001	
nhfcl*bl	6	25.584	4.264	4.040	0.001	

Area 5

Source	DF	Type III SS	Mean Square	F Value	Pr > F	
Model	204	20828.649	102.101	159.410	<.0001	R–Square= 0.401
						CV =
yr	46	3490.617	75.883	118.470	<.0001	65.205
qt	3	220.418	73.473	114.710	<.0001	
nhfcl	5	63.153	12.631	19.720	<.0001	
bl	1	16.441	16.441	25.670	<.0001	
ml	1	5.324	5.324	8.310	0.004	
yr*qt	138	1493.706	10.824	16.900	<.0001	
nhfcl*ml	5	16.824	3.365	5.250	<.0001	
nhfcl*bl	5	28.386	5.677	8.860	<.0001	

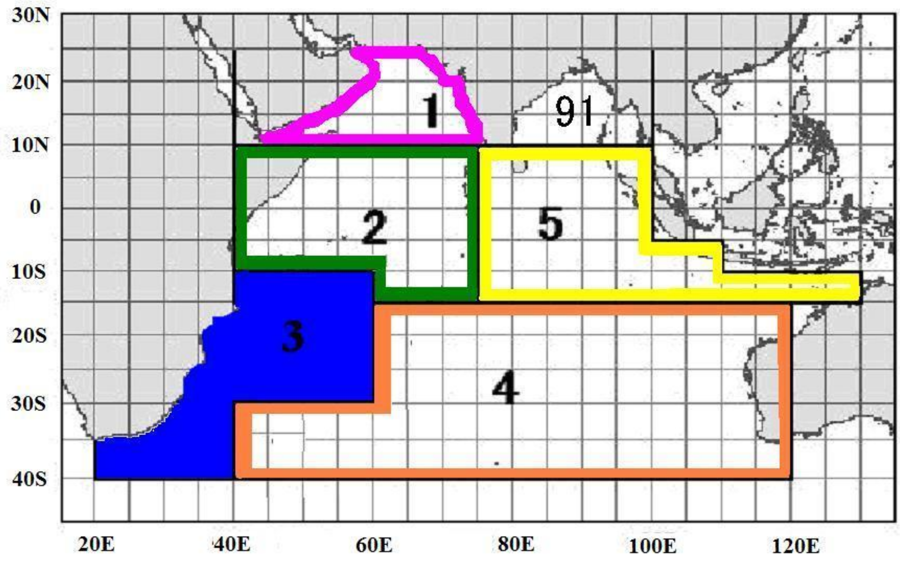


Fig. 1. Definition of sub-areas used in this study. Main fishing ground (areas 2, 3 and 5) and whole Indian Ocean (sub-areas 1-5) categories in this paper.

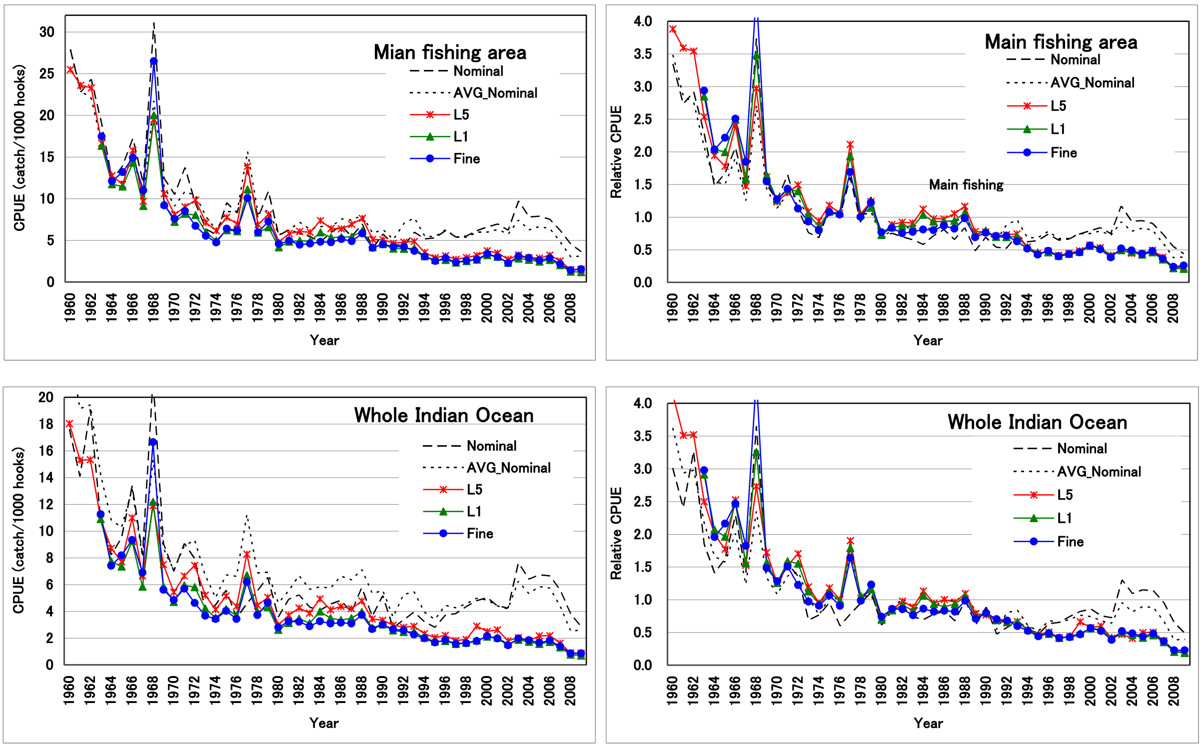


Fig. 2. Annual based CPUE in number standardized using L5, L1 and fine (set by set) data sets from 1960 to 2009 for main fishing ground (top) and whole (bottom) Indian Ocean expressed in relative (left figure) and real (right figure) scale overlaid with nominal CPUE.

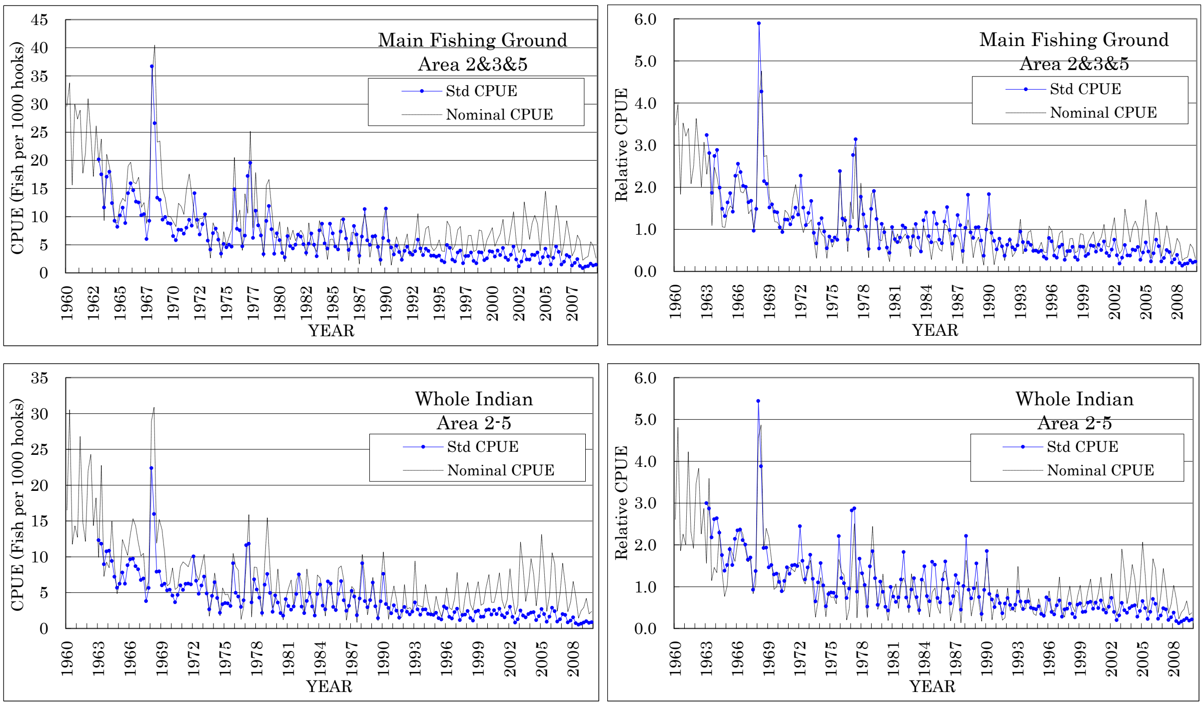
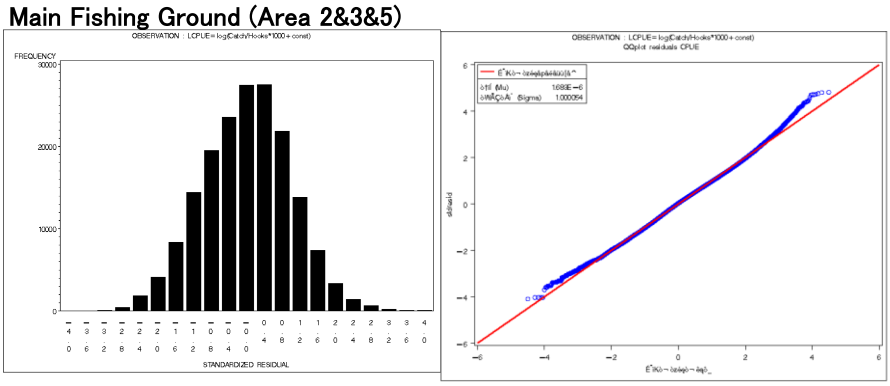


Fig. 3. Quarter based CPUE in number standardized using L1 data set from 1960 to 2009 for main fishing ground (top) and whole (bottom) Indian Ocean expressed in relative (left figure) and real (right figure) scale overlaid with nominal CPUE.

1963–2009 Year base (1 degree X 1 degree X month)
Main Fishing Ground (Area 2&3&5)



1963–2009 Year base (1 degree X 1 degree X month)
Whole Indian (Area 2–5)

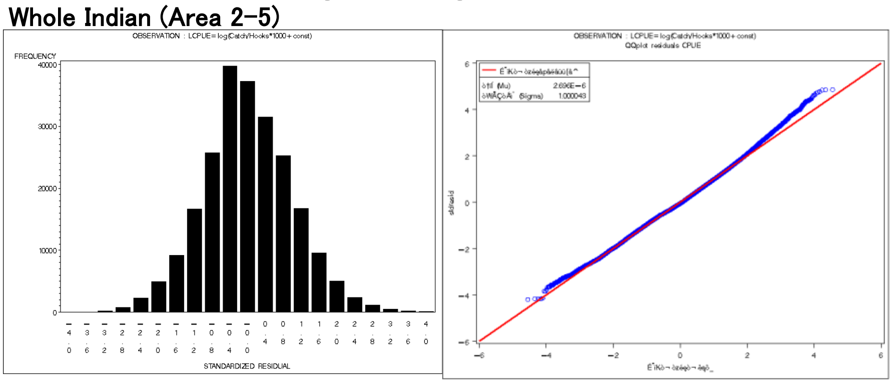


Fig. 4 Standardized residuals of annual based CPUE standardization using L1 data set for main fishing ground (top) and whole (bottom) Indian Ocean

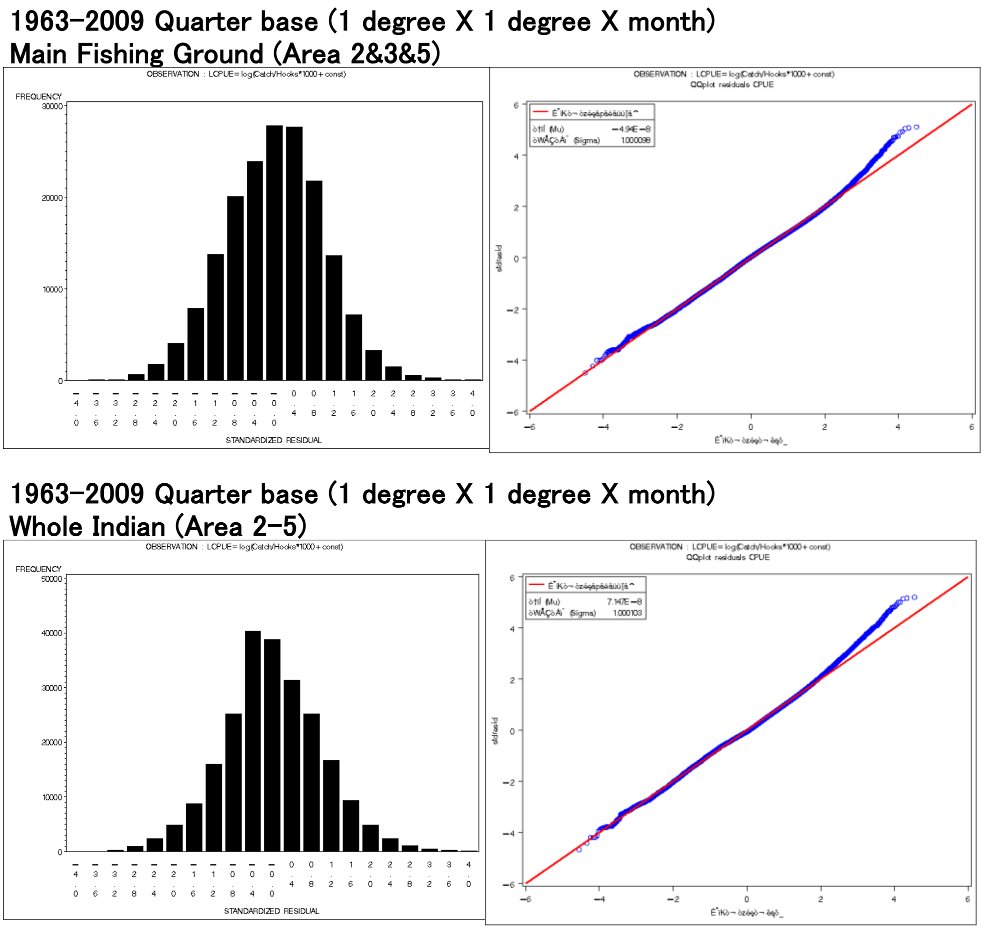


Fig. 5. Standardized residuals of quarter based CPUE standardization using L1 data set for main fishing ground (top) and whole (bottom) Indian Ocean

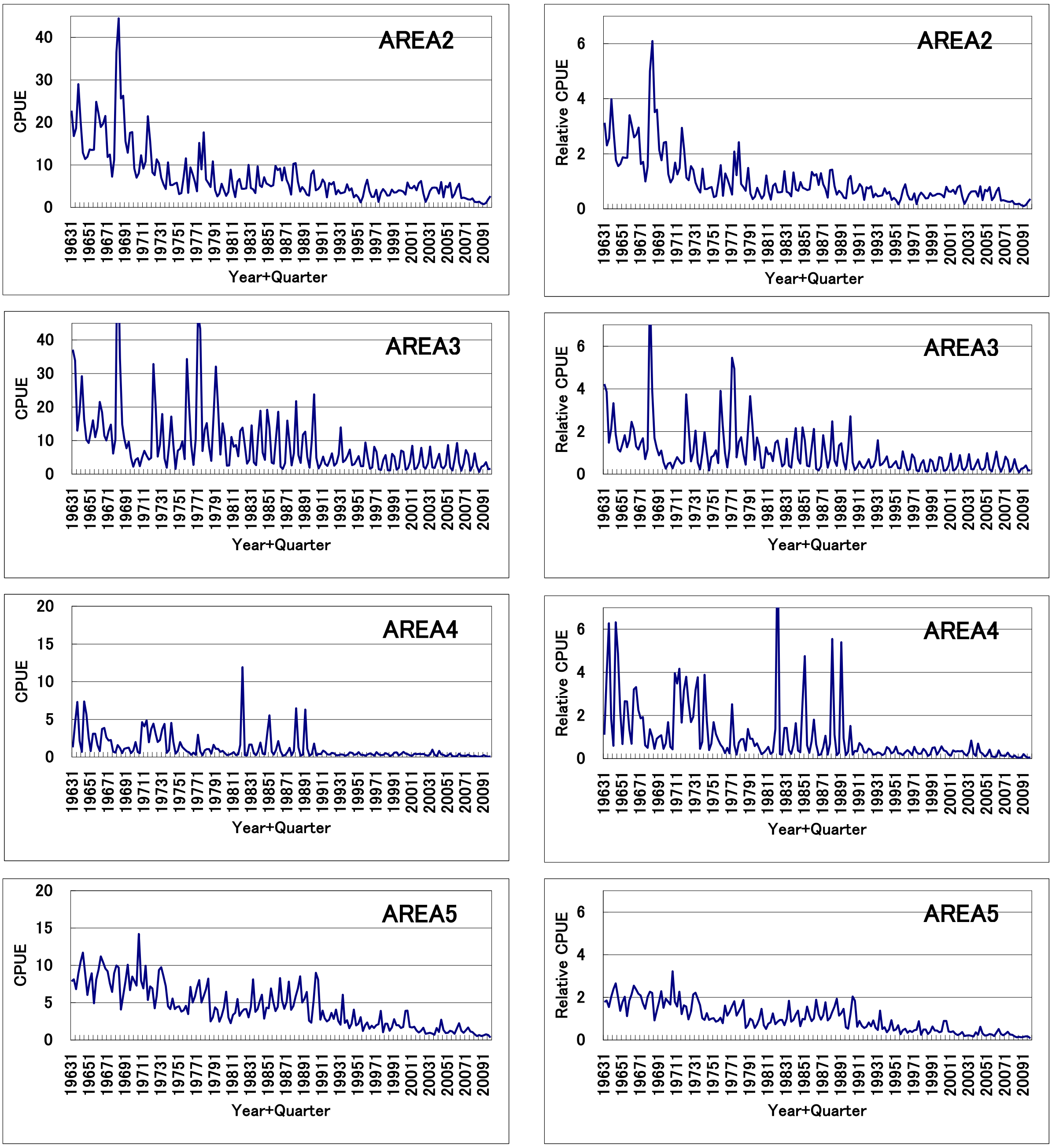


Fig. 6. Standardized quarter based CPUE in number from 1963 to 2009 for each five areas in whole Indian Ocean expressed in relative (left figure) and real (right figure) scale.

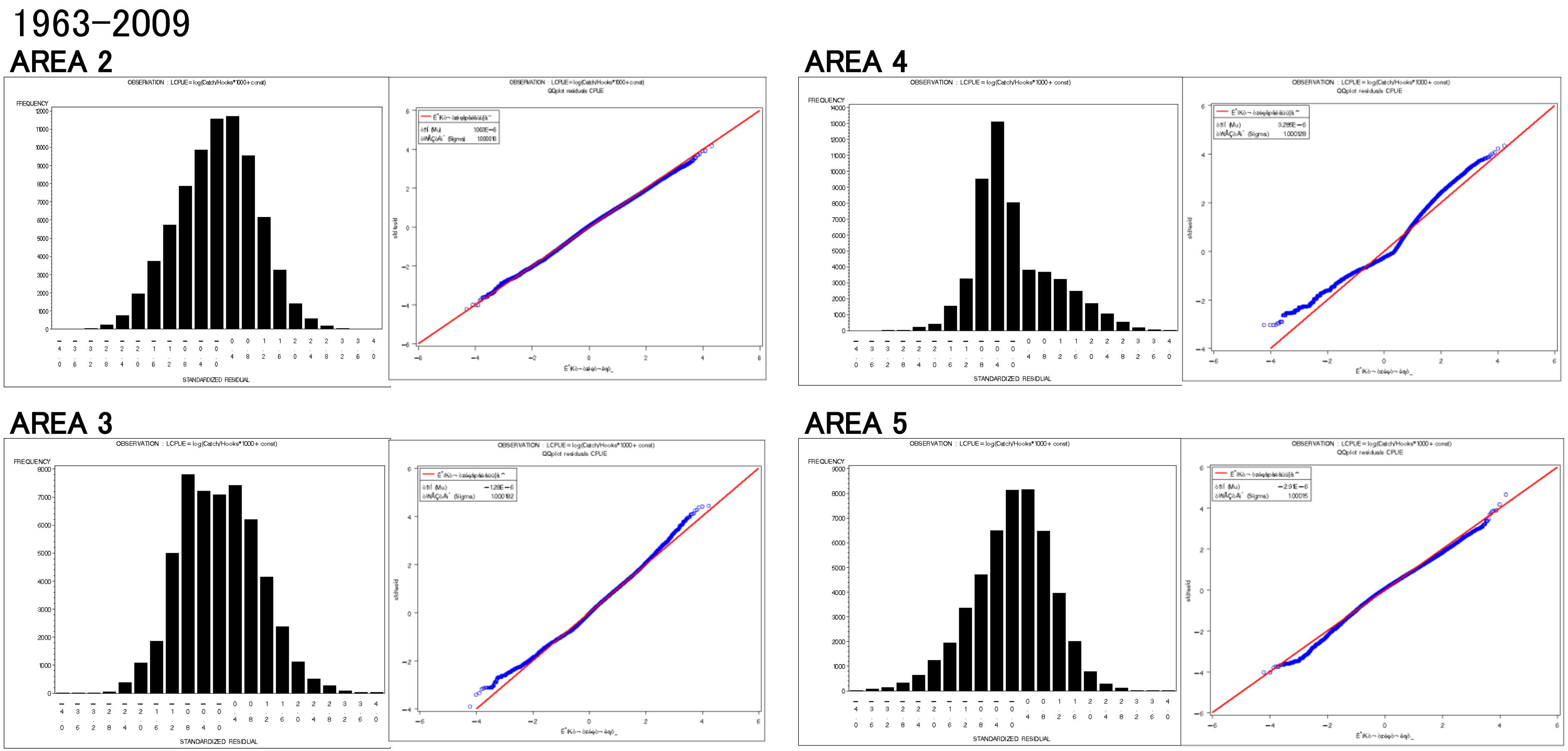


Fig. 7. Standardized residuals of quarter based CPUE standardization for each of five areas in whole Indian Ocean expressed as histograms and QQ plots.

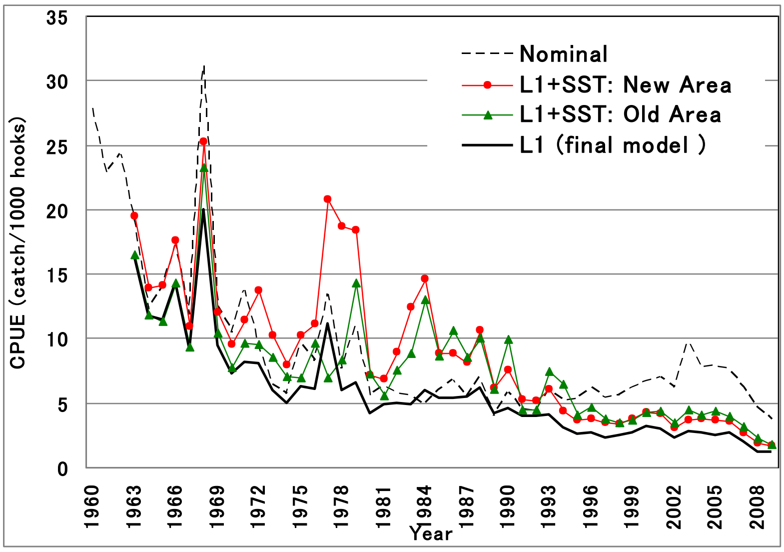


Fig. 8 Comparison of effect of SST on the trend of standardized CPUE for the main fishing area between old and new Area 3 definitions overlaying with CPUE standardized by final model without SST and nominal CPUE.

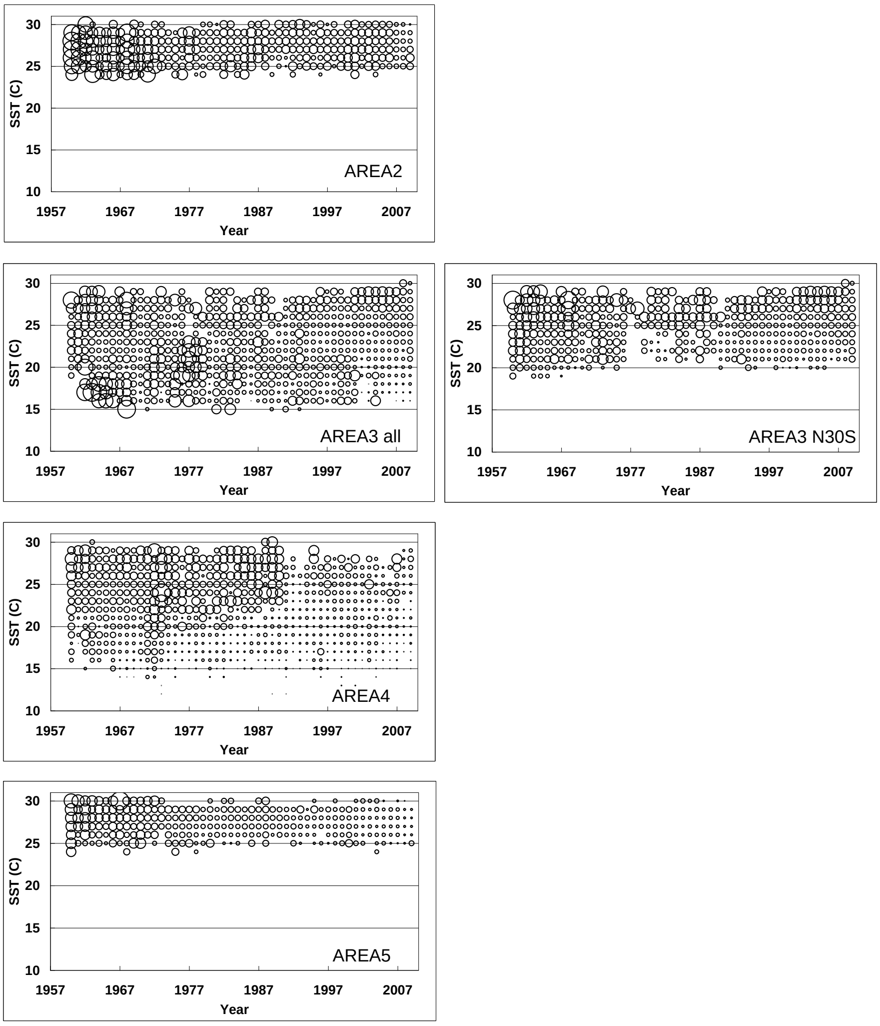


Fig. 9 Historical changer in CPUE by SST from 1963 to 2009 in each Area.

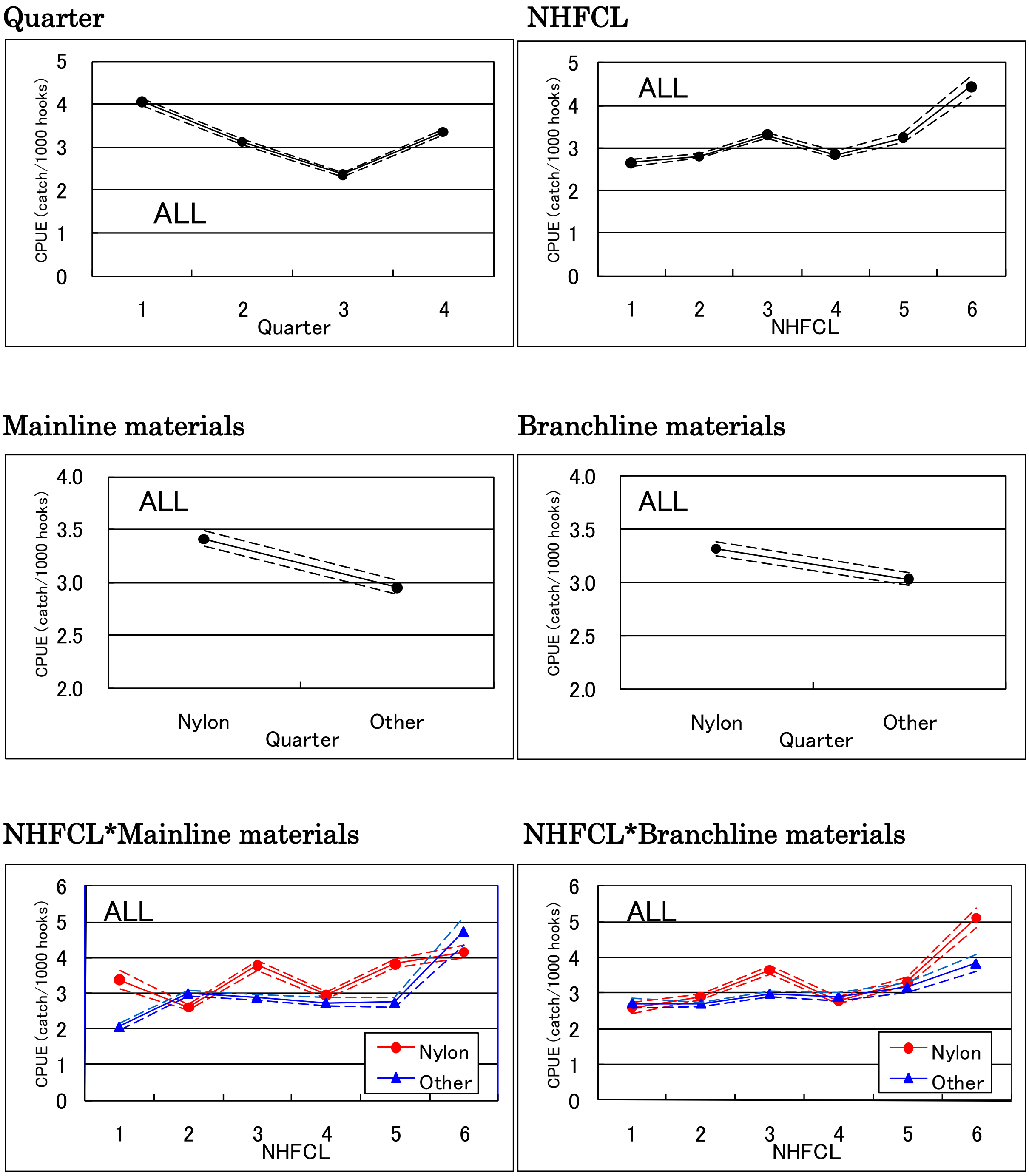
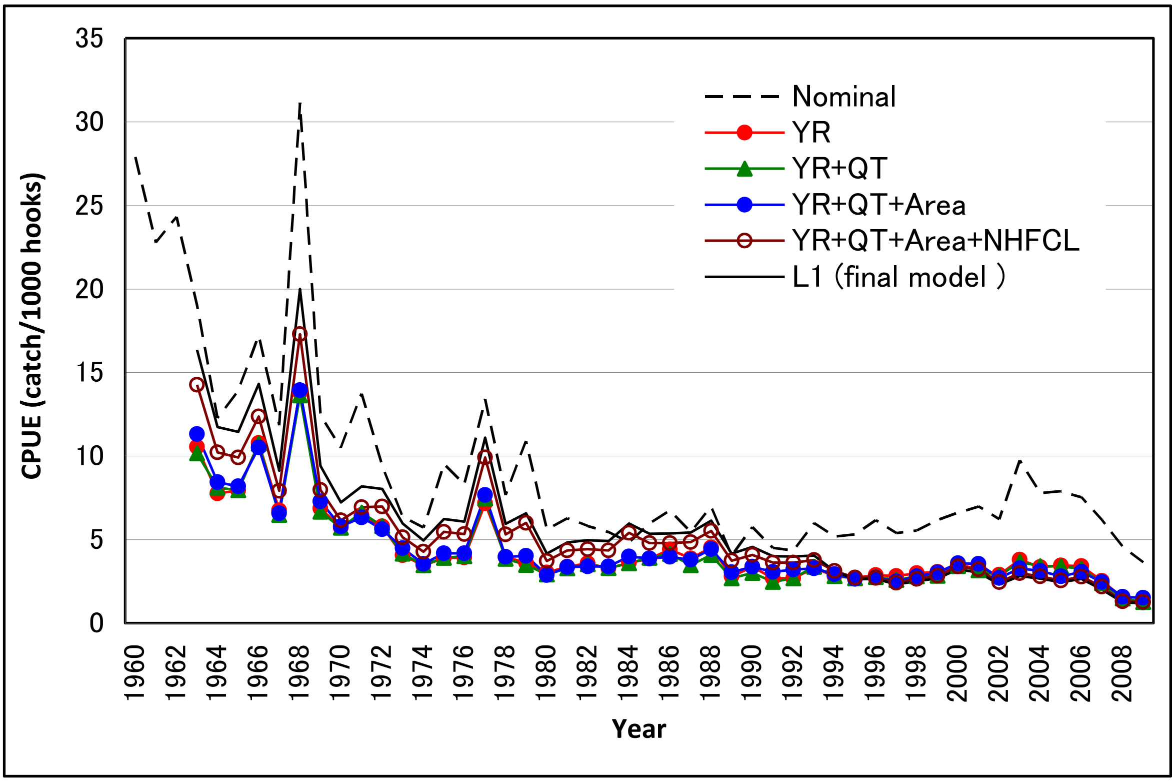


Fig. 10. Trends of CPUE standardized for each of quarter, NHFCL, gear (main-line and branch-line) materials and interaction of NHFCL and gear materials.



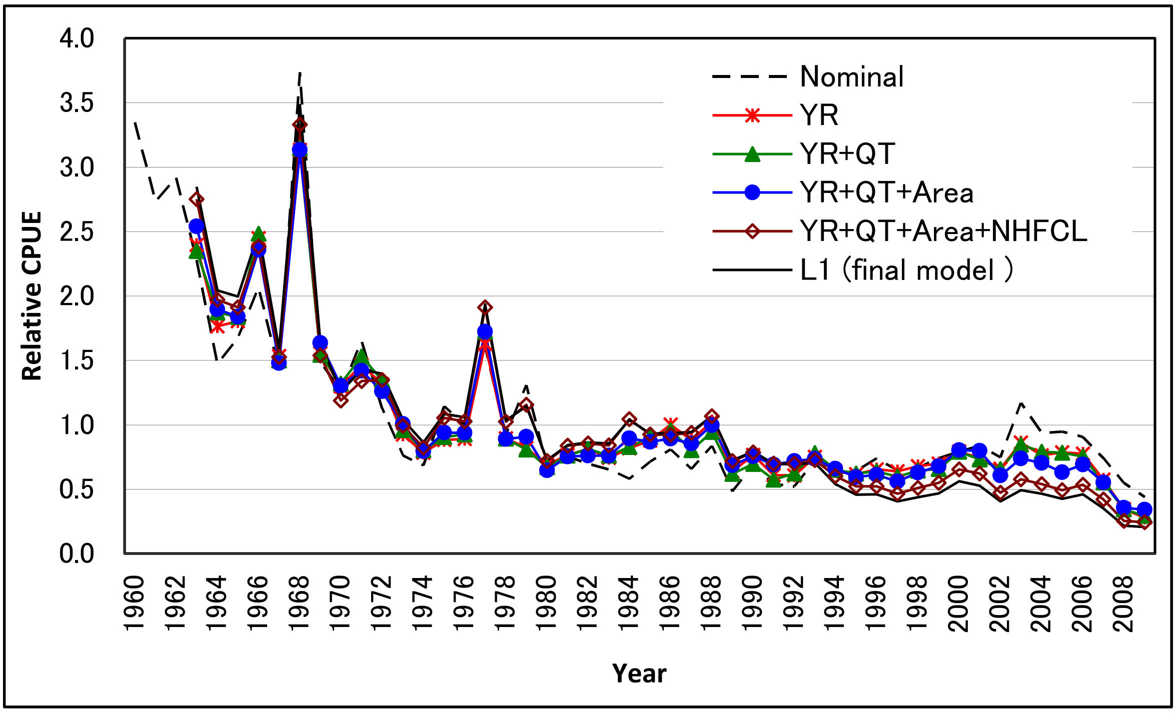


Fig.11 CPUEs standardized by the models in which each explanatory factor (main and related interaction factors) was added in stepwise, expressed in real (top) and relative (bottom) scales with nominal CPUE. In the relative CPUE, averaged CPUE from1963 to 2009 was set to 1.0.

Appendix table 1. Annual value of yellowfin CPUE standardized using L1 data set in main and whole Indian Ocean for 1963-2009 expressed in real and relative scale in which the average of each period is 1.0, and variance.

Annual CPUE (using L1 data set: 1 degree X 1 degree X month)

Main (Area2&3&5) 1963-2009				Whole (Area2-5) 1963-2009			
year	cpue_p	dev_t	Relative CPUE	year	cpue_p	dev_t	Relative CPUE
1960				1960			
1961				1961			
1962				1962			
1963	16.3492	0.0004	2.8467	1963	10.8920	0.0004	2.9101
1964	11.7324	0.0004	2.0429	1964	7.7363	0.0003	2.0670
1965	11.4523	0.0004	1.9941	1965	7.3462	0.0003	1.9627
1966	14.3173	0.0003	2.4930	1966	9.2440	0.0003	2.4698
1967	9.1146	0.0003	1.5870	1967	5.8455	0.0002	1.5618
1968	19.9901	0.0004	3.4807	1968	12.1816	0.0003	3.2547
1969	9.4047	0.0004	1.6376	1969	5.8637	0.0003	1.5667
1970	7.2240	0.0005	1.2579	1970	4.6983	0.0003	1.2553
1971	8.1864	0.0005	1.4254	1971	5.9402	0.0003	1.5871
1972	8.0246	0.0007	1.3973	1972	5.8021	0.0007	1.5502
1973	5.9666	0.0008	1.0389	1973	4.2196	0.0005	1.1274
1974	4.9538	0.0005	0.8626	1974	3.5128	0.0004	0.9385
1975	6.2280	0.0005	1.0844	1975	4.1752	0.0004	1.1155
1976	6.0815	0.0009	1.0589	1976	3.6791	0.0006	0.9830
1977	11.1067	0.0016	1.9339	1977	6.6900	0.0009	1.7874
1978	5.9376	0.0006	1.0339	1978	3.9474	0.0005	1.0547
1979	6.5689	0.0007	1.1438	1979	4.3287	0.0006	1.1565
1980	4.1667	0.0005	0.7255	1980	2.6223	0.0005	0.7006
1981	4.8344	0.0004	0.8418	1981	3.1304	0.0004	0.8364
1982	4.9576	0.0004	0.8632	1982	3.4514	0.0005	0.9221
1983	4.9025	0.0004	0.8536	1983	3.1136	0.0004	0.8319
1984	5.9563	0.0004	1.0371	1984	3.9891	0.0003	1.0658
1985	5.3454	0.0003	0.9307	1985	3.4919	0.0003	0.9330
1986	5.3593	0.0003	0.9332	1986	3.3507	0.0003	0.8952
1987	5.4197	0.0004	0.9437	1987	3.4873	0.0004	0.9317
1988	6.1342	0.0004	1.0681	1988	3.9507	0.0004	1.0555
1989	4.1574	0.0005	0.7239	1989	2.7760	0.0006	0.7417
1990	4.5555	0.0005	0.7932	1990	3.0164	0.0004	0.8059
1991	3.9982	0.0006	0.6962	1991	2.5651	0.0004	0.6853
1992	3.9819	0.0007	0.6933	1992	2.4657	0.0005	0.6588
1993	4.0415	0.0006	0.7037	1993	2.4782	0.0004	0.6621
1994	3.0982	0.0005	0.5395	1994	2.0397	0.0003	0.5450
1995	2.6241	0.0004	0.4569	1995	1.7398	0.0002	0.4648
1996	2.6468	0.0003	0.4609	1996	1.7871	0.0002	0.4775
1997	2.3270	0.0002	0.4052	1997	1.5593	0.0002	0.4166
1998	2.5176	0.0002	0.4384	1998	1.6426	0.0002	0.4389
1999	2.6855	0.0002	0.4676	1999	1.8209	0.0002	0.4865
2000	3.2224	0.0002	0.5611	2000	2.1054	0.0002	0.5625
2001	3.0276	0.0003	0.5272	2001	2.0294	0.0002	0.5422
2002	2.3211	0.0002	0.4042	2002	1.5651	0.0002	0.4182
2003	2.8243	0.0003	0.4918	2003	1.8706	0.0003	0.4998
2004	2.6619	0.0003	0.4635	2004	1.7207	0.0003	0.4597
2005	2.4448	0.0003	0.4257	2005	1.5690	0.0003	0.4192
2006	2.6367	0.0002	0.4591	2006	1.7063	0.0002	0.4559
2007	2.0150	0.0002	0.3509	2007	1.3129	0.0003	0.3508
2008	1.2411	0.0002	0.2161	2008	0.7596	0.0002	0.2029
2009	1.1828	0.0002	0.2060	2009	0.6925	0.0002	0.1850

Appendix table 2. Quartely value of yellowfin CPUE standardized using L1 data set in main and whole Indian Ocean for 1963-2009 expressed in real and relative scale in which the average of each period is 1.0, and variance.

Quarterly CPUE (using L1 data set: 1 degree X 1 degree X month)
1963-2009

Year	Quarter	Main Fishing Ground (Area2&3&5)			Whole Indian Ocean (Area1-5)		
		CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE
1963	1	20.1509	0.0010	3.2367	12.3178	0.0009	2.9942
1963	2	17.4813	0.0013	2.8079	11.8011	0.0041	2.8686
1963	3	11.5996	0.0025	1.8631	8.9573	0.0015	2.1774
1963	4	17.0534	0.0012	2.7391	10.7422	0.0008	2.6112
1964	1	17.9438	0.0012	2.8822	10.8452	0.0009	2.6363
1964	2	12.3746	0.0010	1.9876	9.4118	0.0021	2.2878
1964	3	9.2495	0.0011	1.4857	7.2068	0.0013	1.7518
1964	4	8.1741	0.0008	1.3129	5.6740	0.0006	1.3792
1965	1	10.1766	0.0009	1.6346	6.2317	0.0007	1.5148
1965	2	11.5636	0.0010	1.8574	7.7918	0.0022	1.8940
1965	3	8.8191	0.0010	1.4165	6.2395	0.0011	1.5167
1965	4	14.1336	0.0010	2.2702	8.8118	0.0007	2.1420
1966	1	15.9054	0.0015	2.5547	9.6374	0.0010	2.3427
1966	2	14.6682	0.0009	2.3560	9.7144	0.0022	2.3614
1966	3	12.6383	0.0009	2.0300	8.6759	0.0012	2.1090
1966	4	12.4944	0.0007	2.0069	8.2418	0.0006	2.0034
1967	1	10.2210	0.0007	1.6417	6.7562	0.0006	1.6423
1967	2	10.4345	0.0006	1.6760	6.9628	0.0006	1.6925
1967	3	6.0118	0.0009	0.9656	3.7980	0.0006	0.9232
1967	4	9.2290	0.0009	1.4824	5.6390	0.0006	1.3707
1968	1	36.6747	0.0012	5.8907	22.3836	0.0009	5.4410
1968	2	26.5843	0.0011	4.2700	15.9526	0.0008	3.8778
1968	3	13.3352	0.0011	2.1419	7.9159	0.0007	1.9242
1968	4	12.9471	0.0010	2.0796	7.9486	0.0007	1.9322
1969	1	9.4339	0.0008	1.5153	6.0111	0.0009	1.4612
1969	2	9.8959	0.0009	1.5895	6.2398	0.0008	1.5168
1969	3	8.8253	0.0012	1.4175	5.3028	0.0007	1.2890
1969	4	8.7180	0.0013	1.4003	5.3950	0.0009	1.3114
1970	1	6.5094	0.0013	1.0455	4.5742	0.0015	1.1119
1970	2	5.8079	0.0014	0.9329	3.6551	0.0010	0.8885
1970	3	7.6556	0.0024	1.2297	4.6754	0.0012	1.1365
1970	4	7.6274	0.0013	1.2251	6.0113	0.0008	1.4612
1971	1	6.9449	0.0011	1.1155	5.3731	0.0010	1.3061
1971	2	8.0003	0.0017	1.2850	6.2029	0.0010	1.5078
1971	3	9.4165	0.0016	1.5125	6.2456	0.0009	1.5182
1971	4	8.3781	0.0021	1.3457	6.1350	0.0013	1.4913
1972	1	14.1503	0.0022	2.2728	10.0503	0.0148	2.4430
1972	2	9.4057	0.0027	1.5108	6.6530	0.0026	1.6172
1972	3	6.8195	0.0022	1.0954	4.8271	0.0015	1.1734
1972	4	8.6333	0.0039	1.3867	5.9904	0.0026	1.4562
1973	1	10.3905	0.0030	1.6689	7.2350	0.0072	1.7587
1973	2	5.7023	0.0033	0.9159	4.8760	0.0024	1.1853
1973	3	4.1216	0.0028	0.6620	2.6583	0.0016	0.6462
1973	4	7.0338	0.0019	1.1298	4.5238	0.0011	1.0997
1974	1	7.8479	0.0016	1.2605	6.4333	0.0015	1.5638
1974	2	5.8946	0.0026	0.9468	4.2389	0.0015	1.0304
1974	3	3.4157	0.0016	0.5486	2.1746	0.0010	0.5286
1974	4	5.1437	0.0013	0.8262	3.3764	0.0012	0.8207

Appendix table 2.　Continued.

Year	Quarter	Main Fishing Ground (Area2&3&5)			Whole Indian Ocean (Area1-5)		
		CPUE	t-dev	Relative CPUE	Tropical CPUE	t-dev	Relative CPUE
1975	1	4.5174	0.0023	0.7256	3.5368	0.0019	0.8597
1975	2	5.0027	0.0023	0.8035	3.4956	0.0013	0.8497
1975	3	4.6530	0.0010	0.7474	3.1279	0.0007	0.7603
1975	4	14.8274	0.0018	2.3816	9.0835	0.0012	2.2080
1976	1	7.8130	0.0016	1.2549	4.9578	0.0048	1.2051
1976	2	7.5541	0.0035	1.2133	4.4455	0.0028	1.0806
1976	3	4.7075	0.0038	0.7561	2.9970	0.0019	0.7285
1976	4	6.6036	0.0055	1.0607	3.9230	0.0029	0.9536
1977	1	17.2071	0.0063	2.7638	11.6050	0.0065	2.8210
1977	2	19.5283	0.0167	3.1367	11.8101	0.0087	2.8708
1977	3	6.2002	0.0037	0.9959	3.6157	0.0020	0.8789
1977	4	11.0285	0.0067	1.7714	6.8523	0.0033	1.6657
1978	1	8.4366	0.0019	1.3551	5.4249	0.0031	1.3187
1978	2	6.6303	0.0046	1.0650	4.2759	0.0025	1.0394
1978	3	3.3190	0.0022	0.5331	2.1442	0.0014	0.5212
1978	4	9.2142	0.0025	1.4800	6.1045	0.0018	1.4839
1979	1	11.8567	0.0017	1.9044	7.5955	0.0035	1.8463
1979	2	7.7358	0.0030	1.2425	4.9351	0.0024	1.1996
1979	3	3.3910	0.0023	0.5447	2.3233	0.0014	0.5648
1979	4	7.0141	0.0033	1.1266	4.6094	0.0023	1.1205
1980	1	5.7939	0.0016	0.9306	3.6018	0.0038	0.8755
1980	2	3.5084	0.0024	0.5635	2.1228	0.0029	0.5160
1980	3	2.7392	0.0025	0.4400	1.7588	0.0016	0.4275
1980	4	6.5272	0.0020	1.0484	4.0780	0.0013	0.9913
1981	1	4.7629	0.0010	0.7650	3.1362	0.0017	0.7624
1981	2	4.3289	0.0020	0.6953	2.6128	0.0026	0.6351
1981	3	4.9902	0.0024	0.8015	3.0553	0.0013	0.7427
1981	4	6.7757	0.0016	1.0883	4.8120	0.0012	1.1697
1982	1	6.4289	0.0010	1.0326	7.5176	0.0021	1.8274
1982	2	5.0762	0.0020	0.8153	3.0369	0.0055	0.7382
1982	3	3.5564	0.0011	0.5712	2.1358	0.0011	0.5192
1982	4	5.1805	0.0015	0.8321	3.8245	0.0020	0.9297
1983	1	6.9805	0.0011	1.1212	4.9360	0.0029	1.1999
1983	2	4.9855	0.0031	0.8008	3.0678	0.0021	0.7457
1983	3	2.9362	0.0011	0.4716	1.7926	0.0009	0.4357
1983	4	7.5377	0.0017	1.2107	4.7963	0.0014	1.1659
1984	1	8.7256	0.0012	1.4015	6.1075	0.0014	1.4846
1984	2	5.2161	0.0021	0.8378	3.1778	0.0014	0.7725
1984	3	4.3039	0.0011	0.6913	2.6620	0.0009	0.6471
1984	4	8.7042	0.0015	1.3981	6.5512	0.0011	1.5925
1985	1	7.0073	0.0011	1.1255	6.2598	0.0019	1.5216
1985	2	4.6791	0.0014	0.7516	2.9913	0.0009	0.7271
1985	3	4.1634	0.0009	0.6687	2.5585	0.0007	0.6219
1985	4	7.3448	0.0018	1.1797	4.8123	0.0014	1.1698
1986	1	9.4993	0.0007	1.5258	6.5890	0.0009	1.6017
1986	2	6.1009	0.0021	0.9799	3.9185	0.0025	0.9525
1986	3	4.0738	0.0013	0.6543	2.4468	0.0009	0.5948
1986	4	5.2270	0.0026	0.8396	3.1578	0.0014	0.7676
1987	1	8.3168	0.0011	1.3359	5.2422	0.0009	1.2743
1987	2	6.8130	0.0115	1.0943	4.4496	0.0067	1.0816
1987	3	3.0165	0.0036	0.4845	1.8440	0.0018	0.4482
1987	4	6.4297	0.0016	1.0327	4.1659	0.0012	1.0127

Appendix table 2. Continued.

Year	Quarter	Main Fishing Ground (Area2&3&5) CPUE	t-dev	Relative CPUE	Whole Indian Ocean (Area1-5) Tropical CPUE	t-dev	Relative CPUE
1988	1	11.3133	0.0011	1.8172	9.0964	0.0019	2.2112
1988	2	5.7705	0.0113	0.9269	3.7975	0.0061	0.9231
1988	3	4.9556	0.0016	0.7960	2.9528	0.0012	0.7178
1988	4	6.4784	0.0015	1.0406	3.9484	0.0014	0.9598
1989	1	6.5334	0.0017	1.0494	6.3938	0.0023	1.5542
1989	2	4.5751	0.0032	0.7349	3.0813	0.0050	0.7490
1989	3	2.2969	0.0041	0.3689	1.4168	0.0024	0.3444
1989	4	6.1739	0.0020	0.9917	3.7858	0.0016	0.9203
1990	1	11.4094	0.0011	1.8326	7.6124	0.0011	1.8504
1990	2	5.6830	0.0050	0.9128	3.3899	0.0066	0.8240
1990	3	4.5137	0.0028	0.7250	2.8510	0.0015	0.6930
1990	4	3.2485	0.0024	0.5218	2.0975	0.0018	0.5099
1991	1	4.8168	0.0010	0.7737	3.2140	0.0014	0.7813
1991	2	3.7083	0.0060	0.5956	2.4774	0.0039	0.6022
1991	3	2.2970	0.0038	0.3689	1.4934	0.0017	0.3630
1991	4	3.9093	0.0027	0.6279	2.4418	0.0013	0.5936
1992	1	4.6607	0.0014	0.7486	2.9842	0.0019	0.7254
1992	2	3.5666	0.0204	0.5729	2.3037	0.0086	0.5600
1992	3	3.2122	0.0062	0.5159	1.9536	0.0029	0.4749
1992	4	3.8409	0.0037	0.6169	2.3420	0.0019	0.5693
1993	1	5.8743	0.0015	0.9435	3.6166	0.0030	0.8791
1993	2	4.3248	0.0065	0.6947	2.6612	0.0039	0.6469
1993	3	3.1383	0.0023	0.5041	1.9019	0.0011	0.4623
1993	4	4.2811	0.0030	0.6876	2.6266	0.0015	0.6385
1994	1	3.9097	0.0010	0.6280	2.6553	0.0010	0.6455
1994	2	3.0300	0.0394	0.4867	2.0267	0.0152	0.4927
1994	3	3.0662	0.0051	0.4925	1.9458	0.0022	0.4730
1994	4	2.8522	0.0014	0.4581	1.8801	0.0007	0.4570
1995	1	3.0522	0.0010	0.4902	2.1741	0.0006	0.5285
1995	2	2.1679	0.0038	0.3482	1.4168	0.0017	0.3444
1995	3	1.8815	0.0027	0.3022	1.2537	0.0012	0.3048
1995	4	4.9283	0.0015	0.7916	3.0598	0.0007	0.7438
1996	1	4.4341	0.0008	0.7122	2.8193	0.0005	0.6853
1996	2	2.3291	0.0055	0.3741	1.6075	0.0023	0.3908
1996	3	2.0140	0.0027	0.3235	1.3732	0.0012	0.3338
1996	4	3.6178	0.0009	0.5811	2.2677	0.0005	0.5512
1997	1	3.9405	0.0004	0.6329	2.7534	0.0012	0.6693
1997	2	1.6988	0.0049	0.2729	1.1499	0.0023	0.2795
1997	3	2.9680	0.0013	0.4767	1.8645	0.0006	0.4532
1997	4	2.9921	0.0006	0.4806	1.9266	0.0005	0.4683
1998	1	3.6212	0.0004	0.5816	2.4311	0.0015	0.5910
1998	2	2.1007	0.0015	0.3374	1.4402	0.0011	0.3501
1998	3	1.7174	0.0011	0.2759	1.0850	0.0007	0.2637
1998	4	3.6668	0.0006	0.5890	2.3278	0.0006	0.5658
1999	1	3.6180	0.0006	0.5811	2.4610	0.0010	0.5982
1999	2	2.2610	0.0015	0.3632	1.6168	0.0010	0.3930
1999	3	2.5804	0.0010	0.4145	1.6408	0.0006	0.3988
1999	4	3.8509	0.0005	0.6185	2.5289	0.0008	0.6147
2000	1	3.7400	0.0005	0.6007	2.6269	0.0011	0.6386
2000	2	2.8953	0.0008	0.4650	1.9349	0.0007	0.4703
2000	3	3.9488	0.0009	0.6343	2.5363	0.0006	0.6165
2000	4	3.1535	0.0009	0.5065	1.9980	0.0008	0.4857

Appendix table 2. Continued.

Year	Quarter	Main Fishing Ground (Area2&3&5) CPUE	t-dev	Relative CPUE	Whole Indian Ocean (Area1-5) Tropical CPUE	t-dev	Relative CPUE
2001	1	4.4163	0.0007	0.7094	2.7443	0.0008	0.6671
2001	2	2.7233	0.0010	0.4374	1.8363	0.0008	0.4464
2001	3	2.2872	0.0012	0.3674	1.5443	0.0006	0.3754
2001	4	3.2085	0.0011	0.5154	2.1334	0.0006	0.5186
2002	1	4.6884	0.0009	0.7531	3.0075	0.0008	0.7311
2002	2	2.3731	0.0016	0.3812	1.6152	0.0012	0.3926
2002	3	1.1647	0.0010	0.1871	0.8089	0.0006	0.1966
2002	4	2.0060	0.0006	0.3222	1.2766	0.0005	0.3103
2003	1	3.8922	0.0006	0.6252	2.5045	0.0019	0.6088
2003	2	2.3534	0.0037	0.3780	1.7835	0.0025	0.4335
2003	3	2.3329	0.0020	0.3747	1.5333	0.0011	0.3727
2003	4	3.2092	0.0009	0.5155	2.0017	0.0007	0.4866
2004	1	3.1343	0.0008	0.5034	2.1916	0.0028	0.5327
2004	2	3.6051	0.0023	0.5791	2.2773	0.0017	0.5536
2004	3	1.7116	0.0011	0.2749	1.1494	0.0007	0.2794
2004	4	2.7756	0.0007	0.4458	1.7087	0.0007	0.4154
2005	1	4.2741	0.0007	0.6865	2.6902	0.0012	0.6539
2005	2	2.9274	0.0018	0.4702	1.9907	0.0018	0.4839
2005	3	1.4726	0.0024	0.2365	0.9289	0.0015	0.2258
2005	4	2.6590	0.0010	0.4271	1.6352	0.0007	0.3975
2006	1	4.6864	0.0005	0.7527	2.8874	0.0008	0.7019
2006	2	3.7128	0.0008	0.5964	2.4065	0.0019	0.5850
2006	3	1.4760	0.0007	0.2371	0.9448	0.0006	0.2297
2006	4	1.9646	0.0005	0.3156	1.2657	0.0008	0.3077
2007	1	3.1443	0.0004	0.5050	1.9902	0.0023	0.4838
2007	2	2.8689	0.0007	0.4608	1.8740	0.0011	0.4555
2007	3	1.2990	0.0009	0.2086	0.8359	0.0006	0.2032
2007	4	1.7746	0.0006	0.2850	1.0942	0.0011	0.2660
2008	1	2.4156	0.0005	0.3880	1.5446	0.0015	0.3755
2008	2	1.2197	0.0010	0.1959	0.7212	0.0007	0.1753
2008	3	0.8477	0.0009	0.1362	0.5152	0.0006	0.1252
2008	4	1.0947	0.0005	0.1758	0.6673	0.0010	0.1622
2009	1	1.1711	0.0004	0.1881	0.8204	0.0032	0.1994
2009	2	1.6091	0.0009	0.2585	0.9924	0.0008	0.2412
2009	3	1.2951	0.0020	0.2080	0.7701	0.0010	0.1872
2009	4	1.4366	0.0015	0.2307	0.8716	0.0016	0.2119

Appendix table 3. Quarterly value of yellowfin CPUE standardized using L1 data set for each of five areas in whole Indian Ocean from 1963-2009 expressed in real scale and relative scale with variance.

		AREA2				AREA3				AREA4				AREA5			
yr	qt	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative
1963	1	22.76	0.0026	0.0514	3.1219	37.12	0.0066	0.0812	4.2248	1.27	0.0066	0.0812	1.0955	7.83	0.0025	0.0501	1.7743
1963	2	16.76	0.0039	0.0627	2.2985	33.85	0.0069	0.0829	3.8529	4.48	0.0459	0.2142	3.8527	8.12	0.0032	0.0565	1.8401
1963	3	18.61	0.0142	0.1191	2.5522	12.92	0.0042	0.0651	1.4707	7.29	0.0078	0.0882	6.2712	6.80	0.0036	0.0597	1.5413
1963	4	29.00	0.0030	0.0546	3.9780	18.63	0.0064	0.0801	2.1209	2.14	0.0056	0.0749	1.8440	8.89	0.0030	0.0549	2.0149
1964	1	20.26	0.0028	0.0527	2.7787	29.18	0.0073	0.0856	3.3215	0.68	0.0062	0.0789	0.5887	10.48	0.0029	0.0542	2.3763
1964	2	12.82	0.0022	0.0465	1.7585	16.44	0.0056	0.0748	1.8706	7.35	0.0223	0.1495	6.3166	11.68	0.0030	0.0551	2.6477
1964	3	11.31	0.0057	0.0757	1.5520	10.27	0.0027	0.0520	1.1687	5.67	0.0118	0.1088	4.8724	8.90	0.0022	0.0464	2.0178
1964	4	11.87	0.0027	0.0515	1.6286	9.23	0.0038	0.0614	1.0507	2.54	0.0043	0.0656	2.1854	6.00	0.0021	0.0458	1.3605
1965	1	13.60	0.0021	0.0456	1.8658	12.36	0.0067	0.0818	1.4071	0.77	0.0054	0.0731	0.6632	7.82	0.0020	0.0448	1.7728
1965	2	13.50	0.0023	0.0483	1.8517	16.02	0.0090	0.0948	1.8233	3.09	0.0236	0.1535	2.6595	8.90	0.0019	0.0433	2.0178
1965	3	13.52	0.0034	0.0582	1.8543	10.99	0.0036	0.0600	1.2508	3.08	0.0095	0.0976	2.6491	4.88	0.0027	0.0524	1.1071
1965	4	24.79	0.0029	0.0539	3.4011	13.93	0.0053	0.0730	1.5860	1.58	0.0045	0.0668	1.3626	8.07	0.0027	0.0516	1.8289
1966	1	22.02	0.0019	0.0432	3.0201	21.51	0.0165	0.1284	2.4480	0.78	0.0057	0.0754	0.6737	9.40	0.0022	0.0467	2.1307
1966	2	18.91	0.0018	0.0427	2.5936	18.44	0.0048	0.0696	2.0985	3.73	0.0236	0.1535	3.2032	11.19	0.0030	0.0544	2.5372
1966	3	19.67	0.0027	0.0517	2.6979	11.47	0.0034	0.0585	1.3056	3.85	0.0109	0.1045	3.3103	10.42	0.0027	0.0520	2.3612
1966	4	21.49	0.0019	0.0433	2.9485	10.04	0.0041	0.0641	1.1432	2.61	0.0040	0.0636	2.2441	9.56	0.0023	0.0481	2.1661
1967	1	11.84	0.0017	0.0411	1.6235	12.78	0.0048	0.0690	1.4547	2.17	0.0052	0.0718	1.8641	9.18	0.0019	0.0436	2.0798
1967	2	12.40	0.0020	0.0449	1.7013	14.74	0.0032	0.0563	1.6773	2.24	0.0055	0.0738	1.9219	7.58	0.0018	0.0420	1.7175
1967	3	7.19	0.0030	0.0547	0.9868	6.09	0.0032	0.0561	0.6937	0.71	0.0043	0.0654	0.6071	6.44	0.0027	0.0521	1.4585
1967	4	11.17	0.0023	0.0475	1.5325	10.33	0.0043	0.0656	1.1753	0.58	0.0035	0.0589	0.4959	8.91	0.0031	0.0553	2.0191
1968	1	36.46	0.0021	0.0457	5.0019	77.42	0.0120	0.1094	8.8114	1.58	0.0059	0.0765	1.3564	9.97	0.0019	0.0436	2.2594
1968	2	44.44	0.0022	0.0470	6.0966	34.53	0.0059	0.0765	3.9307	1.18	0.0054	0.0732	1.0135	9.70	0.0036	0.0600	2.1987
1968	3	25.57	0.0027	0.0523	3.5072	14.86	0.0044	0.0667	1.6912	0.51	0.0038	0.0616	0.4418	4.04	0.0038	0.0613	0.9153
1968	4	26.26	0.0021	0.0458	3.6020	10.71	0.0063	0.0791	1.2192	1.06	0.0042	0.0651	0.9110	5.95	0.0028	0.0528	1.3481
1969	1	15.57	0.0020	0.0445	2.1355	7.70	0.0052	0.0724	0.8769	1.16	0.0083	0.0913	1.0016	7.83	0.0023	0.0476	1.7751
1969	2	12.80	0.0028	0.0529	1.7558	9.66	0.0047	0.0688	1.0992	1.25	0.0062	0.0789	1.0777	10.08	0.0026	0.0509	2.2842
1969	3	17.49	0.0029	0.0538	2.3989	4.84	0.0036	0.0601	0.5506	0.51	0.0041	0.0643	0.4427	6.64	0.0045	0.0669	1.5047
1969	4	17.72	0.0030	0.0544	2.4308	2.19	0.0062	0.0789	0.2496	0.82	0.0053	0.0728	0.7071	8.48	0.0038	0.0620	1.9231
1970	1	9.13	0.0030	0.0550	1.2520	4.23	0.0095	0.0976	0.4813	1.96	0.0131	0.1146	1.6889	7.91	0.0026	0.0507	1.7930
1970	2	6.95	0.0042	0.0652	0.9533	4.72	0.0078	0.0882	0.5377	0.62	0.0060	0.0773	0.5347	7.28	0.0033	0.0573	1.6496
1970	3	8.02	0.0129	0.1135	1.0998	2.32	0.0084	0.0919	0.2635	0.50	0.0047	0.0683	0.4261	14.17	0.0025	0.0504	3.2123
1970	4	12.24	0.0032	0.0569	1.6793	4.90	0.0092	0.0962	0.5581	4.60	0.0047	0.0684	3.9546	7.89	0.0027	0.0523	1.7884

Appendix table 3. Continued.

		AREA2				AREA3				AREA4				AREA5			
yr	qt	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative
1971	1	9.10	0.0029	0.0540	1.2489	6.96	0.0061	0.0779	0.7922	4.04	0.0085	0.0923	3.4724	6.89	0.0028	0.0527	1.5626
1971	2	10.77	0.0042	0.0651	1.4773	5.52	0.0119	0.1089	0.6278	4.84	0.0053	0.0726	4.1625	9.94	0.0031	0.0560	2.2530
1971	3	21.43	0.0038	0.0616	2.9402	4.30	0.0089	0.0941	0.4899	1.93	0.0039	0.0622	1.6590	5.32	0.0042	0.0649	1.2066
1971	4	15.56	0.0030	0.0548	2.1346	4.81	0.0150	0.1225	0.5470	3.67	0.0073	0.0856	3.1569	7.17	0.0051	0.0713	1.6242
1972	1	8.18	0.0035	0.0594	1.1226	32.78	0.0172	0.1313	3.7312	4.41	0.1750	0.4184	3.7906	6.90	0.0045	0.0670	1.5643
1972	2	7.55	0.0040	0.0636	1.0363	20.12	0.0227	0.1508	2.2896	3.05	0.0198	0.1408	2.6218	4.21	0.0051	0.0711	0.9546
1972	3	11.27	0.0035	0.0595	1.5455	5.18	0.0073	0.0856	0.5891	1.96	0.0090	0.0948	1.6876	5.88	0.0083	0.0912	1.3322
1972	4	10.32	0.0041	0.0637	1.4154	8.73	0.0146	0.1210	0.9940	2.25	0.0152	0.1232	1.9331	9.37	0.0145	0.1204	2.1246
1973	1	6.94	0.0062	0.0789	0.9514	17.91	0.0223	0.1493	2.0380	3.69	0.0757	0.2751	3.1717	9.74	0.0055	0.0743	2.2067
1973	2	5.39	0.0061	0.0780	0.7400	4.67	0.0172	0.1313	0.5317	4.38	0.0151	0.1227	3.7682	8.51	0.0088	0.0937	1.9281
1973	3	4.29	0.0047	0.0683	0.5881	1.86	0.0072	0.0849	0.2121	0.52	0.0072	0.0846	0.4506	7.21	0.0109	0.1043	1.6333
1973	4	10.59	0.0045	0.0672	1.4531	8.43	0.0092	0.0958	0.9591	0.90	0.0056	0.0747	0.7762	4.49	0.0051	0.0715	1.0178
1974	1	5.22	0.0042	0.0652	0.7165	17.19	0.0109	0.1043	1.9570	4.52	0.0124	0.1112	3.8876	4.12	0.0029	0.0541	0.9329
1974	2	5.22	0.0052	0.0719	0.7161	8.89	0.0146	0.1210	1.0122	2.03	0.0068	0.0826	1.7413	5.55	0.0064	0.0800	1.2583
1974	3	5.56	0.0039	0.0626	0.7623	1.47	0.0071	0.0840	0.1676	0.45	0.0060	0.0774	0.3869	4.14	0.0045	0.0667	0.9373
1974	4	5.77	0.0048	0.0692	0.7915	7.01	0.0068	0.0823	0.7974	0.80	0.0090	0.0946	0.6911	4.39	0.0027	0.0519	0.9957
1975	1	3.08	0.0046	0.0682	0.4220	7.55	0.0237	0.1539	0.8590	1.96	0.0133	0.1154	1.6895	4.50	0.0023	0.0478	1.0194
1975	2	3.32	0.0060	0.0773	0.4557	9.78	0.0150	0.1225	1.1128	1.32	0.0064	0.0799	1.1314	3.77	0.0043	0.0658	0.8545
1975	3	7.09	0.0030	0.0548	0.9723	4.46	0.0055	0.0744	0.5073	1.01	0.0049	0.0700	0.8707	3.96	0.0026	0.0514	0.8974
1975	4	11.54	0.0036	0.0600	1.5833	34.28	0.0130	0.1141	3.9021	0.74	0.0071	0.0842	0.6383	4.57	0.0037	0.0609	1.0364
1976	1	3.38	0.0044	0.0662	0.4635	19.83	0.0079	0.0887	2.2574	0.59	0.0534	0.2310	0.5078	3.43	0.0041	0.0636	0.7782
1976	2	9.37	0.0056	0.0747	1.2857	8.64	0.0259	0.1609	0.9839	0.28	0.0191	0.1381	0.2414	7.08	0.0072	0.0851	1.6055
1976	3	7.79	0.0142	0.1191	1.0691	2.69	0.0084	0.0916	0.3065	0.57	0.0067	0.0818	0.4891	5.00	0.0093	0.0965	1.1325
1976	4	5.94	0.0206	0.1437	0.8143	10.46	0.0253	0.1591	1.1908	0.27	0.0102	0.1010	0.2302	5.79	0.0090	0.0947	1.3133
1977	1	3.75	0.0142	0.1193	0.5145	47.87	0.0467	0.2160	5.4488	2.93	0.0517	0.2273	2.5193	7.01	0.0098	0.0988	1.5882
1977	2	15.16	0.0129	0.1135	2.0798	43.30	0.0563	0.2374	4.9288	0.72	0.0307	0.1753	0.6230	8.00	0.0647	0.2544	1.8133
1977	3	8.91	0.0133	0.1154	1.2217	6.82	0.0094	0.0970	0.7757	0.21	0.0079	0.0890	0.1809	5.01	0.0092	0.0958	1.1345
1977	4	17.64	0.0037	0.0606	2.4195	13.24	0.0308	0.1756	1.5067	0.86	0.0102	0.1012	0.7359	5.87	0.0244	0.1563	1.3313
1978	1	6.55	0.0015	0.0389	0.8989	15.19	0.0107	0.1036	1.7291	1.03	0.0296	0.1721	0.8875	6.78	0.0066	0.0812	1.5359
1978	2	5.72	0.0021	0.0455	0.7846	8.19	0.0172	0.1312	0.9318	1.05	0.0105	0.1024	0.8992	8.22	0.0190	0.1377	1.8639
1978	3	4.74	0.0107	0.1035	0.6505	3.89	0.0098	0.0988	0.4428	0.43	0.0073	0.0855	0.3684	2.46	0.0024	0.0486	0.5584
1978	4	10.80	0.0049	0.0703	1.4815	17.40	0.0192	0.1386	1.9804	1.59	0.0116	0.1078	1.3691	3.01	0.0049	0.0697	0.6826

Appendix table 3. Continued.

		AREA2				AREA3				AREA4				AREA5			
yr	qt	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative
1979	1	4.01	0.0035	0.0592	0.5506	32.09	0.0076	0.0869	3.6525	1.06	0.0359	0.1894	0.9116	4.36	0.0052	0.0723	0.9876
1979	2	2.53	0.0067	0.0819	0.3477	19.87	0.0175	0.1323	2.2611	1.06	0.0161	0.1270	0.9123	4.02	0.0068	0.0822	0.9115
1979	3	3.18	0.0054	0.0735	0.4368	5.79	0.0076	0.0870	0.6586	0.67	0.0071	0.0844	0.5740	2.43	0.0070	0.0837	0.5510
1979	4	5.53	0.0133	0.1154	0.7583	15.09	0.0148	0.1215	1.7180	0.82	0.0136	0.1166	0.7025	3.20	0.0048	0.0693	0.7256
1980	1	4.01	0.0042	0.0645	0.5499	11.29	0.0056	0.0747	1.2854	0.53	0.0402	0.2004	0.4598	4.34	0.0049	0.0700	0.9833
1980	2	2.69	0.0044	0.0662	0.3687	2.50	0.0158	0.1258	0.2840	0.23	0.0251	0.1584	0.1986	6.44	0.0056	0.0747	1.4587
1980	3	3.60	0.0126	0.1122	0.4944	2.55	0.0068	0.0822	0.2907	0.31	0.0083	0.0912	0.2692	3.01	0.0037	0.0607	0.6816
1980	4	8.82	0.0030	0.0546	1.2093	11.06	0.0162	0.1271	1.2584	0.45	0.0069	0.0830	0.3848	2.24	0.0044	0.0663	0.5086
1981	1	4.61	0.0017	0.0417	0.6319	8.12	0.0049	0.0697	0.9242	0.62	0.0172	0.1311	0.5367	3.34	0.0036	0.0596	0.7579
1981	2	2.38	0.0043	0.0656	0.3262	8.65	0.0106	0.1029	0.9844	0.25	0.0233	0.1526	0.2113	3.62	0.0054	0.0732	0.8205
1981	3	6.08	0.0040	0.0635	0.8344	5.29	0.0050	0.0706	0.6023	0.34	0.0055	0.0743	0.2954	5.49	0.0096	0.0978	1.2432
1981	4	6.66	0.0024	0.0490	0.9131	12.90	0.0144	0.1202	1.4686	1.60	0.0079	0.0887	1.3721	3.22	0.0031	0.0558	0.7293
1982	1	4.34	0.0016	0.0397	0.5951	13.84	0.0048	0.0690	1.5752	11.90	0.0220	0.1483	10.2323	3.77	0.0035	0.0589	0.8537
1982	2	4.31	0.0030	0.0551	0.5911	8.67	0.0097	0.0983	0.9866	0.24	0.0591	0.2431	0.2041	4.10	0.0066	0.0811	0.9289
1982	3	4.47	0.0022	0.0471	0.6130	3.09	0.0042	0.0649	0.3520	0.21	0.0091	0.0953	0.1776	4.14	0.0039	0.0622	0.9374
1982	4	9.98	0.0016	0.0395	1.3695	4.20	0.0145	0.1203	0.4779	1.65	0.0177	0.1331	1.4196	3.02	0.0032	0.0567	0.6837
1983	1	4.51	0.0011	0.0338	0.6182	14.54	0.0115	0.1072	1.6549	1.65	0.0311	0.1763	1.4160	4.39	0.0022	0.0472	0.9960
1983	2	4.23	0.0015	0.0391	0.5798	3.48	0.0210	0.1451	0.3959	0.45	0.0129	0.1138	0.3899	8.11	0.0092	0.0961	1.8377
1983	3	3.30	0.0043	0.0654	0.4525	2.61	0.0053	0.0726	0.2966	0.24	0.0067	0.0819	0.2050	3.75	0.0019	0.0431	0.8504
1983	4	9.62	0.0022	0.0468	1.3199	11.30	0.0174	0.1317	1.2856	0.75	0.0094	0.0971	0.6491	4.12	0.0027	0.0518	0.9341
1984	1	5.10	0.0016	0.0405	0.7002	18.89	0.0119	0.1093	2.1495	1.91	0.0123	0.1111	1.6383	5.22	0.0022	0.0472	1.1841
1984	2	4.76	0.0025	0.0496	0.6532	6.37	0.0203	0.1425	0.7251	0.42	0.0081	0.0898	0.3618	6.05	0.0039	0.0621	1.3718
1984	3	7.09	0.0041	0.0642	0.9728	4.21	0.0050	0.0705	0.4791	0.33	0.0069	0.0831	0.2805	2.84	0.0022	0.0470	0.6438
1984	4	5.57	0.0024	0.0493	0.7644	19.21	0.0134	0.1155	2.1868	3.05	0.0075	0.0864	2.6262	4.33	0.0028	0.0525	0.9825
1985	1	5.28	0.0016	0.0394	0.7238	13.93	0.0117	0.1081	1.5858	5.52	0.0186	0.1364	4.7484	4.23	0.0015	0.0392	0.9588
1985	2	4.92	0.0021	0.0457	0.6748	3.41	0.0085	0.0923	0.3885	0.70	0.0057	0.0758	0.6057	6.88	0.0039	0.0623	1.5604
1985	3	5.16	0.0022	0.0465	0.7079	3.12	0.0039	0.0628	0.3548	0.31	0.0051	0.0717	0.2627	5.12	0.0026	0.0509	1.1596
1985	4	9.72	0.0015	0.0382	1.3334	10.77	0.0148	0.1217	1.2253	0.93	0.0096	0.0982	0.7966	3.84	0.0046	0.0679	0.8711
1986	1	8.76	0.0012	0.0349	1.2010	18.59	0.0073	0.0854	2.1155	2.09	0.0089	0.0942	1.7986	4.42	0.0013	0.0366	1.0026
1986	2	9.13	0.0019	0.0439	1.2524	2.17	0.0078	0.0886	0.2467	0.76	0.0219	0.1481	0.6563	8.27	0.0084	0.0916	1.8754
1986	3	6.29	0.0030	0.0551	0.8629	1.47	0.0046	0.0681	0.1673	0.18	0.0058	0.0762	0.1543	5.28	0.0040	0.0632	1.1972
1986	4	9.41	0.0018	0.0430	1.2906	3.23	0.0326	0.1806	0.3674	0.22	0.0061	0.0782	0.1909	4.17	0.0026	0.0506	0.9440

Appendix table 3. Continued.

		AREA2				AREA3				AREA4				AREA5			
yr	qt	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative
1987	1	6.48	0.0013	0.0356	0.8893	15.97	0.0118	0.1088	1.8180	0.59	0.0070	0.0839	0.5062	5.08	0.0017	0.0409	1.1516
1987	2	5.21	0.0019	0.0432	0.7149	9.13	0.0106	0.1031	1.0393	1.22	0.0301	0.1734	1.0483	7.79	0.0588	0.2424	1.7663
1987	3	2.94	0.0053	0.0726	0.4032	2.57	0.0039	0.0621	0.2919	0.21	0.0062	0.0785	0.1791	4.02	0.0154	0.1240	0.9120
1987	4	10.21	0.0028	0.0525	1.4004	6.14	0.0156	0.1249	0.6991	0.79	0.0078	0.0881	0.6819	4.52	0.0021	0.0459	1.0236
1988	1	10.36	0.0013	0.0362	1.4211	21.72	0.0128	0.1131	2.4723	6.45	0.0189	0.1376	5.5452	5.80	0.0017	0.0415	1.3145
1988	2	5.98	0.0021	0.0459	0.8200	5.61	0.0081	0.0901	0.6383	1.28	0.0235	0.1531	1.1023	6.88	0.0589	0.2426	1.5596
1988	3	3.71	0.0046	0.0681	0.5087	3.34	0.0038	0.0617	0.3805	0.17	0.0082	0.0905	0.1499	8.52	0.0053	0.0727	1.9320
1988	4	4.76	0.0026	0.0506	0.6525	11.73	0.0143	0.1194	1.3347	0.31	0.0109	0.1043	0.2636	4.99	0.0022	0.0471	1.1309
1989	1	4.05	0.0014	0.0374	0.5554	12.62	0.0163	0.1276	1.4368	6.27	0.0215	0.1467	5.3926	5.52	0.0033	0.0571	1.2514
1989	2	2.96	0.0030	0.0546	0.4058	5.15	0.0075	0.0869	0.5863	1.09	0.0472	0.2172	0.9359	6.41	0.0139	0.1180	1.4536
1989	3	2.75	0.0231	0.1520	0.3773	1.89	0.0037	0.0606	0.2153	0.18	0.0111	0.1052	0.1555	2.58	0.0064	0.0801	0.5854
1989	4	7.78	0.0045	0.0670	1.0673	10.07	0.0117	0.1083	1.1462	0.36	0.0103	0.1017	0.3136	2.30	0.0048	0.0695	0.5207
1990	1	8.68	0.0022	0.0469	1.1903	23.79	0.0096	0.0982	2.7083	1.76	0.0092	0.0958	1.5107	5.21	0.0020	0.0443	1.1807
1990	2	4.00	0.0037	0.0607	0.5486	4.80	0.0083	0.0913	0.5465	0.20	0.0590	0.2430	0.1752	8.98	0.0227	0.1505	2.0363
1990	3	4.30	0.0134	0.1159	0.5895	1.63	0.0035	0.0593	0.1851	0.41	0.0060	0.0774	0.3525	8.08	0.0062	0.0786	1.8318
1990	4	4.94	0.0030	0.0552	0.6782	2.97	0.0251	0.1585	0.3386	0.38	0.0124	0.1112	0.3279	2.69	0.0029	0.0543	0.6098
1991	1	6.54	0.0020	0.0452	0.8970	5.19	0.0076	0.0874	0.5905	0.83	0.0132	0.1148	0.7121	3.91	0.0023	0.0482	0.8873
1991	2	5.74	0.0096	0.0980	0.7881	3.04	0.0057	0.0756	0.3465	0.68	0.0210	0.1447	0.5814	2.89	0.0252	0.1588	0.6557
1991	3	2.33	0.0099	0.0994	0.3189	2.44	0.0031	0.0559	0.2776	0.33	0.0040	0.0630	0.2800	2.48	0.0139	0.1179	0.5610
1991	4	5.70	0.0094	0.0972	0.7818	4.06	0.0142	0.1190	0.4622	0.32	0.0040	0.0635	0.2731	2.71	0.0044	0.0663	0.6147
1992	1	5.37	0.0039	0.0624	0.7368	6.15	0.0048	0.0695	0.7000	0.54	0.0172	0.1310	0.4623	3.62	0.0040	0.0634	0.8194
1992	2	5.94	0.0057	0.0757	0.8154	2.47	0.0040	0.0633	0.2813	0.45	0.0122	0.1103	0.3905	2.81	0.1074	0.3276	0.6360
1992	3	3.04	0.0246	0.1570	0.4167	3.23	0.0022	0.0470	0.3672	0.21	0.0070	0.0835	0.1788	4.04	0.0179	0.1338	0.9157
1992	4	4.01	0.0036	0.0599	0.5501	5.87	0.0307	0.1752	0.6680	0.23	0.0071	0.0841	0.1988	2.53	0.0078	0.0885	0.5731
1993	1	3.28	0.0046	0.0675	0.4504	13.94	0.0057	0.0755	1.5861	0.33	0.0312	0.1765	0.2831	2.02	0.0037	0.0609	0.4587
1993	2	3.40	0.0035	0.0595	0.4661	3.55	0.0047	0.0684	0.4042	0.29	0.0190	0.1377	0.2468	6.06	0.0324	0.1801	1.3737
1993	3	3.56	0.0059	0.0765	0.4887	4.14	0.0025	0.0503	0.4712	0.18	0.0040	0.0634	0.1546	2.26	0.0083	0.0909	0.5121
1993	4	5.43	0.0024	0.0492	0.7451	5.41	0.0269	0.1640	0.6162	0.26	0.0048	0.0689	0.2277	2.63	0.0061	0.0779	0.5950
1994	1	3.91	0.0023	0.0482	0.5364	7.27	0.0032	0.0563	0.8277	0.62	0.0077	0.0878	0.5291	1.57	0.0032	0.0569	0.3556
1994	2	4.47	0.0032	0.0564	0.6130	2.66	0.0018	0.0427	0.3029	0.52	0.0054	0.0736	0.4463	2.17	0.2161	0.4649	0.4925
1994	3	2.30	0.0077	0.0879	0.3161	2.96	0.0017	0.0410	0.3365	0.28	0.0036	0.0601	0.2371	4.05	0.0225	0.1500	0.9181
1994	4	2.89	0.0022	0.0472	0.3968	4.13	0.0069	0.0833	0.4701	0.36	0.0027	0.0521	0.3075	1.93	0.0045	0.0668	0.4380

Appendix table 3. Continued.

yr	qt	AREA2 CPUE	AREA2 Dev	AREA2 std_err	AREA2 Relative	AREA3 CPUE	AREA3 Dev	AREA3 std_err	AREA3 Relative	AREA4 CPUE	AREA4 Dev	AREA4 std_err	AREA4 Relative	AREA5 CPUE	AREA5 Dev	AREA5 std_err	AREA5 Relative
1995	1	2.30	0.0036	0.0596	0.3152	5.33	0.0024	0.0489	0.6067	0.64	0.0036	0.0598	0.5535	2.16	0.0028	0.0531	0.4906
1995	2	1.15	0.0058	0.0761	0.1572	2.36	0.0019	0.0440	0.2688	0.28	0.0044	0.0660	0.2385	3.05	0.0170	0.1303	0.6913
1995	3	2.46	0.0118	0.1087	0.3369	2.36	0.0023	0.0482	0.2690	0.27	0.0021	0.0460	0.2302	1.17	0.0067	0.0817	0.2650
1995	4	4.99	0.0020	0.0443	0.6842	9.39	0.0123	0.1110	1.0689	0.17	0.0022	0.0469	0.1491	1.97	0.0031	0.0554	0.4464
1996	1	6.50	0.0022	0.0471	0.8914	4.95	0.0019	0.0440	0.5629	0.34	0.0035	0.0592	0.2958	2.31	0.0026	0.0507	0.5247
1996	2	3.77	0.0029	0.0535	0.5173	1.57	0.0020	0.0449	0.1789	0.46	0.0035	0.0593	0.3916	1.49	0.0282	0.1681	0.3366
1996	3	2.46	0.0033	0.0575	0.3370	1.92	0.0017	0.0413	0.2189	0.34	0.0026	0.0505	0.2881	1.88	0.0127	0.1127	0.4269
1996	4	2.43	0.0012	0.0340	0.3340	8.10	0.0039	0.0625	0.9216	0.18	0.0028	0.0525	0.1518	1.59	0.0029	0.0542	0.3611
1997	1	4.08	0.0013	0.0355	0.5595	6.66	0.0017	0.0416	0.7580	0.62	0.0136	0.1164	0.5367	1.98	0.0014	0.0367	0.4478
1997	2	1.23	0.0013	0.0359	0.1690	1.42	0.0019	0.0439	0.1615	0.33	0.0060	0.0774	0.2874	2.08	0.0261	0.1616	0.4710
1997	3	3.33	0.0024	0.0488	0.4561	1.19	0.0018	0.0426	0.1360	0.25	0.0022	0.0472	0.2138	3.87	0.0056	0.0746	0.8770
1997	4	4.26	0.0009	0.0294	0.5842	4.23	0.0028	0.0528	0.4809	0.26	0.0034	0.0585	0.2200	1.03	0.0020	0.0451	0.2330
1998	1	3.63	0.0008	0.0275	0.4973	5.68	0.0016	0.0395	0.6463	0.51	0.0174	0.1319	0.4426	2.15	0.0014	0.0367	0.4880
1998	2	2.72	0.0010	0.0314	0.3732	1.16	0.0019	0.0431	0.1317	0.38	0.0076	0.0870	0.3264	2.16	0.0075	0.0866	0.4906
1998	3	2.80	0.0021	0.0456	0.3839	1.08	0.0018	0.0428	0.1232	0.13	0.0037	0.0611	0.1129	1.21	0.0045	0.0673	0.2747
1998	4	4.17	0.0017	0.0408	0.5726	6.02	0.0024	0.0492	0.6853	0.22	0.0044	0.0664	0.1905	1.67	0.0020	0.0443	0.3780
1999	1	3.42	0.0020	0.0448	0.4686	5.17	0.0020	0.0443	0.5882	0.58	0.0104	0.1019	0.4967	2.78	0.0016	0.0399	0.6297
1999	2	3.53	0.0039	0.0623	0.4841	1.25	0.0022	0.0464	0.1426	0.60	0.0060	0.0773	0.5152	1.96	0.0053	0.0730	0.4433
1999	3	3.96	0.0040	0.0632	0.5433	1.91	0.0024	0.0494	0.2170	0.21	0.0036	0.0596	0.1787	1.95	0.0021	0.0461	0.4429
1999	4	3.94	0.0012	0.0345	0.5398	6.97	0.0026	0.0515	0.7930	0.39	0.0078	0.0883	0.3369	1.57	0.0012	0.0345	0.3563
2000	1	3.69	0.0011	0.0334	0.5060	6.65	0.0023	0.0477	0.7573	0.66	0.0115	0.1073	0.5656	1.71	0.0015	0.0390	0.3878
2000	2	2.98	0.0028	0.0531	0.4091	1.30	0.0038	0.0614	0.1482	0.43	0.0051	0.0715	0.3704	3.90	0.0016	0.0403	0.8837
2000	3	5.83	0.0030	0.0544	0.7998	1.64	0.0025	0.0505	0.1864	0.38	0.0033	0.0577	0.3288	3.90	0.0027	0.0515	0.8848
2000	4	4.59	0.0018	0.0422	0.6290	3.52	0.0030	0.0548	0.4003	0.20	0.0063	0.0795	0.1756	1.73	0.0028	0.0530	0.3920
2001	1	4.48	0.0032	0.0568	0.6140	8.40	0.0024	0.0486	0.9560	0.15	0.0069	0.0830	0.1305	1.64	0.0015	0.0381	0.3723
2001	2	5.02	0.0024	0.0489	0.6887	1.41	0.0041	0.0638	0.1601	0.44	0.0059	0.0767	0.3776	1.75	0.0029	0.0534	0.3969
2001	3	3.96	0.0037	0.0611	0.5430	1.83	0.0025	0.0497	0.2087	0.37	0.0024	0.0494	0.3175	1.25	0.0036	0.0601	0.2840
2001	4	5.65	0.0023	0.0483	0.7749	3.44	0.0037	0.0611	0.3910	0.40	0.0028	0.0527	0.3422	0.97	0.0037	0.0605	0.2188
2002	1	6.16	0.0015	0.0385	0.8449	7.83	0.0020	0.0449	0.8917	0.38	0.0059	0.0770	0.3243	1.22	0.0037	0.0608	0.2762
2002	2	3.29	0.0022	0.0467	0.4519	2.21	0.0046	0.0675	0.2512	0.41	0.0086	0.0926	0.3505	1.64	0.0062	0.0786	0.3709
2002	3	1.27	0.0027	0.0517	0.1741	1.60	0.0030	0.0552	0.1819	0.24	0.0028	0.0524	0.2068	0.80	0.0031	0.0557	0.1809
2002	4	2.40	0.0010	0.0316	0.3296	3.19	0.0056	0.0749	0.3626	0.15	0.0033	0.0574	0.1327	0.89	0.0013	0.0356	0.2022

Appendix table 3. Continued.

		AREA2				AREA3				AREA4				AREA5			
yr	qt	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative	CPUE	Dev	std_err	Relative
2003	1	3.83	0.0013	0.0363	0.5251	8.22	0.0025	0.0500	0.9352	0.35	0.0220	0.1482	0.2991	0.96	0.0020	0.0445	0.2178
2003	2	4.56	0.0020	0.0444	0.6252	1.94	0.0047	0.0688	0.2207	0.97	0.0146	0.1209	0.8322	0.85	0.0177	0.1332	0.1916
2003	3	4.64	0.0030	0.0548	0.6360	1.84	0.0037	0.0611	0.2089	0.28	0.0042	0.0648	0.2384	0.69	0.0082	0.0904	0.1561
2003	4	4.60	0.0011	0.0327	0.6310	3.91	0.0058	0.0765	0.4445	0.13	0.0049	0.0697	0.1126	1.58	0.0027	0.0523	0.3579
2004	1	3.23	0.0010	0.0321	0.4428	6.03	0.0025	0.0499	0.6858	0.80	0.0315	0.1774	0.6899	1.05	0.0034	0.0579	0.2381
2004	2	5.92	0.0018	0.0422	0.8125	2.15	0.0042	0.0650	0.2445	0.35	0.0111	0.1056	0.2976	2.72	0.0104	0.1021	0.6156
2004	3	2.29	0.0022	0.0467	0.3138	1.64	0.0018	0.0425	0.1863	0.26	0.0042	0.0650	0.2243	1.31	0.0044	0.0664	0.2976
2004	4	4.99	0.0013	0.0365	0.6848	2.74	0.0033	0.0574	0.3124	0.11	0.0053	0.0724	0.0917	0.91	0.0025	0.0497	0.2055
2005	1	4.63	0.0009	0.0296	0.6355	8.65	0.0024	0.0485	0.9846	0.20	0.0119	0.1093	0.1684	0.94	0.0030	0.0551	0.2127
2005	2	5.74	0.0012	0.0351	0.7869	1.98	0.0026	0.0514	0.2249	0.47	0.0144	0.1198	0.4071	1.22	0.0086	0.0928	0.2758
2005	3	2.26	0.0014	0.0376	0.3102	1.04	0.0016	0.0401	0.1187	0.11	0.0084	0.0918	0.0980	1.10	0.0120	0.1097	0.2498
2005	4	3.07	0.0009	0.0300	0.4214	4.70	0.0033	0.0573	0.5348	0.08	0.0048	0.0695	0.0670	0.80	0.0039	0.0627	0.1818
2006	1	4.58	0.0008	0.0290	0.6282	9.28	0.0021	0.0454	1.0565	0.09	0.0089	0.0945	0.0782	1.53	0.0018	0.0427	0.3478
2006	2	5.51	0.0007	0.0274	0.7564	3.42	0.0020	0.0445	0.3891	0.44	0.0211	0.1451	0.3795	2.23	0.0033	0.0572	0.5065
2006	3	2.17	0.0018	0.0422	0.2970	0.99	0.0017	0.0410	0.1123	0.16	0.0051	0.0711	0.1408	1.22	0.0025	0.0495	0.2764
2006	4	2.26	0.0009	0.0308	0.3099	3.08	0.0021	0.0458	0.3500	0.15	0.0088	0.0936	0.1326	0.94	0.0017	0.0411	0.2135
2007	1	2.07	0.0007	0.0269	0.2845	7.15	0.0019	0.0435	0.8134	0.14	0.0271	0.1646	0.1203	1.27	0.0015	0.0383	0.2877
2007	2	1.84	0.0006	0.0247	0.2529	5.76	0.0028	0.0529	0.6561	0.32	0.0108	0.1038	0.2723	1.66	0.0026	0.0507	0.3755
2007	3	1.78	0.0016	0.0395	0.2435	0.96	0.0019	0.0435	0.1090	0.14	0.0045	0.0669	0.1162	1.12	0.0034	0.0583	0.2537
2007	4	2.09	0.0012	0.0340	0.2863	2.38	0.0037	0.0606	0.2713	0.07	0.0110	0.1051	0.0610	1.06	0.0017	0.0416	0.2404
2008	1	1.25	0.0012	0.0342	0.1718	6.14	0.0026	0.0511	0.6993	0.16	0.0172	0.1311	0.1376	0.74	0.0014	0.0379	0.1686
2008	2	1.21	0.0009	0.0306	0.1656	2.34	0.0039	0.0621	0.2662	0.05	0.0053	0.0730	0.0446	0.51	0.0037	0.0605	0.1155
2008	3	1.31	0.0019	0.0437	0.1800	0.62	0.0025	0.0502	0.0702	0.04	0.0039	0.0623	0.0313	0.63	0.0030	0.0551	0.1423
2008	4	0.90	0.0015	0.0384	0.1240	2.18	0.0025	0.0500	0.2485	0.05	0.0105	0.1027	0.0452	0.51	0.0014	0.0374	0.1153
2009	1	0.69	0.0010	0.0318	0.0944	2.52	0.0025	0.0501	0.2864	0.23	0.0394	0.1985	0.2015	0.62	0.0011	0.0334	0.1408
2009	2	1.01	0.0019	0.0441	0.1392	3.55	0.0047	0.0686	0.4038	0.10	0.0058	0.0762	0.0863	0.76	0.0026	0.0506	0.1712
2009	3	1.89	0.0099	0.0993	0.2588	1.45	0.0035	0.0587	0.1652	0.04	0.0033	0.0576	0.0334	0.66	0.0035	0.0595	0.1493
2009	4	2.62	0.0085	0.0923	0.3590	1.61	0.0048	0.0694	0.1829	0.05	0.0131	0.1143	0.0451	0.32	0.0014	0.0371	0.0719